ECONOMIC GEOGRAPHY OF INDIA

ECONOMIC GEOGRAPHY OF INDIA

By

R. N. DUBEY, M.A., D. Litt. (Geog.)
Former Professor of Geography, University of Allahabad

Revised and Enlarged
by
BALBIR SINGH NEGI

KITAB MAHAL, ALLAHABAD

1968

First Edition, 1939
Second Edition, 1941
Third Edition, 1943
Fourth Edition, 1945
Fifth Edition, 1946
Sixth Edition, 1951
Seventh Edition, 1954
Eighth Edition, 1957
Ninth Edition, 1961
Tenth Edition, 1964
Eleventh Edition, 1965
Twelfth Edition, 1968

Published by : KITAB MAHAL, ALLAHABAD
Printed by : Eagle Offset Printers, 15, Thornhill Road, Allahabad.

PREFACE TO THE TWELFTH EDITION

About three decades ago, Dr. R. N. Dubey wrote his book "Economic Geography of India". This was an outstanding contribution to the study of economic geography of India. For about three decades it has been the only book available on the subject. A thoroughly revised edition of the same, therefore, needs no apology to make its appearance, especially at the time when the subject is attracting the attention of an increasing number of students and administrators alike.

In bringing out this new edition every care has been taken to delete the irrelevant matter, make necessary amendments in the light of the progress achieved and make the book very comprehensive and reliable.

The pace of economic development in India has been quickened after the inauguration of India's Five Year Plans. For this purpose majority of the chapters have been largely rewritten and others made up to date. There is, however, also a large change in the general arrangement of the material and in the mode of treatment. Not only the original layout of the chapters has been changed but also many new chapters have been added, such as :

Geological History of India, Vegetation, Soils, Land Utilization, Agricultural Problems and distribution of crops, Commercial crops, Plantation crops, Horticulture, Agricultural regions of India, 'Power Resources of India, Mineral Resources of India, Metallurgical, Mechanical, Electrical, Textile, Food and other industries, Population and Races of India, and a new chapter, Regional Geographical Account of States of India.

In fully revising the volume for this new edition opportunity has been taken to bring facts and figures up to date and to review the economic position of India in relation to recent world trends of 'recovery and recession'.

The book is thus progressive in character, while the standard is suitable for University students. Copious modern data have been incorporated in it which every student is expected to cover completely in the short course of his training.

BALBIR SINGH NEGI

PREFACE TO THE FIRST EDITION

This is a modest attempt to write the Economic Geography of such a vast country with such varied resources. During his fourteen years' lecturing on Economic Geography at the University, the author has felt the necessity of a small book which will give the future citizens of India a bird's-eye-view of the geographical environment in which they have been born and the economic resources that are theirs to develop. In these days when battles are fought not for principles but for 'living space', every Indian must know the possibilities of his own 'living space'. There are a number of books on the subject written either from the point of view of the foreigner whose interest is in 'exploitation', or by people who confuse Economics with Economic Geography. The present book tries to deal with the development of Inda's resources as based on geographical factors. A full discussion, therefore, of climate, physical features, vegetation, and soil has preceded the survey of economic resources. In order to help the students in their preparation for examination, questions have been added at the end of every chapter. A large number of sketch maps and diagrams have been given to facilitate the study of the subject.

University of Allahabad **R. N. Dubey**

CONTENTS

Introduction

India was described as 'a jewel in the British Crown'. But when we look at the squalor and poverty of the people of India, considering the vast resources of the country, we cannot fail to remark that the custodians of the 'Crown Jewels' failed miserably to discharge their duty. They did not try to keep this 'jewel' bright. The fact that a country so rich in economic resources as India, should be so poor, does not redound to the credit of the rulers.

The poverty of the people of India is because the resources of the country have not been fully developed. They have not been even properly surveyed. It was only very recently that the Government's interest in the successful prosecution of the two World Wars led to this survey and development to a small extent. But, considering the rapid progress made by such small countries as Japan and Germany before these wars, the efforts in India seemed half-hearted.

The vast though undeveloped resources of India naturally make it 'A Land of the Future', which will acquire its rightful place in the world when these resources are developed. To help India to attain to her greatness in future, Indians' first interest in India should be to have a full knowledge of her resources. We should know the extent and the geographical distribution of the present, as well as the potential resources of our country. This can be done only through the study of Economic Geography of the country.

But the world outside has also got an abiding interest in India. The population map of the world shows certain areas of denser population. Two of these areas occur in Asia; one in India and the other, China. Of these two, India gives shelter to more than one-fifth of the total population of the world. World's interest, therefore, centres on India as a country where such a large proportion of its population has found shelter.

India gave shelter to the Aryan civilization which took root in its soil and spread far and wide from here, subordinating for a time other civilizations of the day. The world's interest, therefore, centres on India also as a home of the Aryan culture.

India's northern boundary is formed by the highest mountain of the world whose highest peak, the Everest, defied Man up to 1953. The world's interest centres on India, therefore, also as a land of adventure where Man is attracted by the beauty of the land.

Our interest, as students of Economic Geography, however, centres on India as a land of vast economic resources which have not yet been fully developed.

The idea of developing economic resources is new in India and arose only out of contact with the Western peoples. For it must be admitted that 'material culture' was never a strong point in the spiritually-minded India of the past. No doubt, there are evidences to show that the Indians practised in the past highly developed arts. These arts must have been practised, however, 'for the sake of art' rather than for any considerable monetary gain. These arts could not have been, therefore, widely spread in the country. The two most important elements of material culture, as used in the modern sense, capital and the market, must have been lacking then. A spiritual culture has obviously no interest in 'capital' and 'market'. These are out of the question in a society which does not possess the most efficient means of communication. The merchant who comes into frequent contact with people and studies their material wants is the person most interested in 'economic resources', and not the ascetic who runs away from the world.

The first effective contacts of India with a merchant of this sort originated through the British, only a few hundred years ago. Our economic resources have not yet, therefore, received full attention. It is only within the last few years, when the Indians began to visit Europe, or America and other developed countries in increasing numbers to see for themselves the economic or material progress achieved there, that attention has been paid to the survey and development of our economic resources.

The survey is still incomplete and the problem of development still baffles solution.

India's neighbours on its land frontiers, excepting now Pakistan, are countries that are hilly and semi-arid. They are not rich in natural resources. Their dry climate is, however, healthy and breeds sturdy warriors. India's rich plains have always been an attraction for these poor but strong neighbours. From time to time, therefore, invasions have been made in India. In the past they came from the North-west through easy passes like the Khyber, which in peace times enabled India to maintain commercial ties with far-off countries. But recently the whole of northern mountain border of India has assumed special significance on account of advances in mountain warfare which have enabled China to attack India from that side, a side which was supposed to be strategically safe on account of rough terrain. The

study of the Economic Geography of our country has to be oriented in the light of these recent developments.

India stands at the head of the Indian Ocean at the very centre of the Eastern Hemisphere commanding trade routes running in all directions and connecting India with countries lying in east, west south-east and south-west such as China, Japan, U.S.A., Great Britain West European countries, Indonesia, Australia and S. Africa etc. There is no other ocean in the world which is named after a country. The Indian Ocean is the only ocean that is named after a country. Two other points are of significance in this situation. India is situated at the southern margin of the big land mass of Eurasia. This, naturally, links it with the Air Pressure Systems of Asia.

In the modern world, the opening of the Suez Canal has enhanced the importance of India's position. For the routes emanating from this canal and the Strait of Malacca are forced to pass near India. The Indian Ocean has very few islands to serve as supply bases for the ships. The ships plying to Australia, therefore, have to visit some ports in India or in Ceylon. But her coastline being regular, very little use has been made by Indians of their situation at the shores of this big ocean. It is true that in the past coastal boats kept certain parts of India in touch with Arabia on the West and South-eastern Asia on the East. But such a contact was necessarily limited. For it must be remembered that the most important centres of activity in India lay in the interior in the Indo-Gangetic Basin, far from the coast. With the advent of the British everything changed, the British being a maritime nation. India now developed an ocean contact with the outside world. Her land contacts now declined. The most important centres of activity now shifted to the coasts where the British ships contacted us. The most favourable ports on the Indian coast gradually developed into good seaports. Calcutta, Bombay, Okha, Kandla, Vishakhapatnam and Madras became the leading ports as well as the centres of European civilisation in India. The forces of modernisation gradually spread from the port towns into the interior chiefly through English education and the railways which were built to connect the port towns with the interior.

The surface area of India is 3305384 sq. kms. This area places India as the seventh largest country in the world. The following table compares the areas of some of the biggest countries of the world :

IN ASIA

Siberia	..	..	..	4192000 Sq. Kilometers
China (Proper)	..	..	..	3930000 " "
Mongolia	..	..	..	4585000 " "
India	..	..	..	3275000 " "

OTHERS

U. S. S. R.	
Russia (in Europe)	20619400 Sq. Kilometres
Canada	10060800 ,, ,,
Brazil	8593600 ,, ,,
U. S. A.	7912400 ,, ,,
Australia	7860000 ,, ,,

An important feature of the Indian area is that most of it is in the service of Man. In Russia and Canada, on the other hand, vast areas remain buried under perpetual snow. In Australia, there are large areas of desert, useless to Man. In Brazil, there are vast areas under tropical forests. Even in the U.S.A. more than 2882000 sq. kms. are included in the Western States which are mostly a desert. This consideration naturally places India in the forefront among the countries of the world.

In population, India occupies an important place in the world. The following table gives the population in 1961 of the countries whose areas have been compared above :—

India	439,202,747 (1961)
China	700,000,000
Soviet Union	208,826,650
Canada	18,500,000
Brazil	63,101,000
U. S. A.	177,726,000
Australia	10,398,170

Taking into consideration this large area and this large population, people have often styled India as a 'continent' or a'sub-continent'. These people have obviously emphasised the differences among the people that are naturally to be expected where the numbers are so large. God has not made any two people alike in all details. Do we then emphasise the points of differences among the members of the same family or the points of unity ? By laying emphasis on these differences, we destroy the family. Similarly, we can also destroy the community and the country. Once we destroy this unity, the systematic development of economic resources becomes well-nigh impossible.

What country is there in the world where differences do not exist ? Even in a small country like Great Britain which has hardly

one-eighth of the population found in India, there are differences among people. The Welsh, the Scotch and the English do not see eye to eye in all matters. They have differences in their physical features. Just consider the different races, that went to England to make the present English nation ! The Scandinavians, the Germans, and the French all went there. To which blood does the present Englishman belong ? There are local differences of relief and climate from one part to the other. The Welsh, the Scotch and the Irish have their own language which is distinct from English. But we do not call Great Britain a 'continent'. We do not call Russia, which has Muslims, Christians, Jews and others living side by side, a continent. Why should India then be singled out for this ? It cannot be said that it is to emphasise the size of India for in that case, there are bigger countries.

Common outlook in essentials of life should be the main test to decide whether India is a country or a continent. The boundaries of India are so well defined that they leave no doubt in our minds that India is a country, a separate whole. The mountain boundaries towards the land frontiers and the sea on the other separate India almost completely from Asia.[1]

The geographical considerations make agriculture the dominant occupation of all people in India, Muslims and Hindus alike. The crops sown by them are alike; the methods of cultivation followed by them are alike. When the monsoon rains fail, they fail alike for the Hindu and the Muslim, or the Sikh. The common interest of the people lies, therefore, in safeguarding India's agriculture.

There are, of course, differences in culture and language from one community to the other; from one state to the other. But these differences have always been subdued by the peculiar geographical characteristics of India. The language of the ruler has always dominated the local languages, and the people of no two states of India have ever found it difficult to be understood by each other because the local languages of the provinces differ. It was partly to establish unity in the country that the Hindu religion built shrines in the different parts of the country visiting of which was a religious duty for the Hindus.

India is, therefore, as much a country as any other in the world.

In spite of the present backward economic development, India has an economic importance of her own. Her teeming millions are looked upon by the world as potential buyers. The importance of

---

1. So says Prof. Chisholm, "There is no part of the world better marked off by Nature as a region by itself than the Indian subcontinent." —L. D. Stamp and S. C. Glimour. Chisholm's *Handbook of Commercial Geog.* 1954, p. 554.

the Indian market for the European manufacturer has been emphasised in this book elsewhere. India is more or less a monopoly producer of certain commodities in the world like mica, shellac, etc. Her cotton, iron, manganese, tea, oilseeds and some other commodities are in demand over large parts of the world. Her developing industries require machinery and skilled labourers. What country is there in the world, with machinery and skill to spare, which is not anxious, therefore, to be invited to take a hand in this development ?

The following pages attempt to give the basis of India's economic importance. This economic importance has been greatly affected by the creation of Pakistan. The partition has taken away from India some of the most fertile and developed agricultural areas. This is shown by the following table showing the highest yield per acre in Pakistan and the loss India suffered due to partition :—

Yields per acre in lbs. and average for 1949-51

	1945-46		1949-51	
	India	Pakistan	India	Pakistan
Rice	703	837	961	1,216
Wheat	541	668	586	833
Maize	..	..	536	916
Cotton	75	170	80	184
Jute	1029	1365	1048	1,400
Tobacco	725	1047	839	..

The loss in industrial raw materials is not confined to raw cotton and raw jute, the supplies of raw skins, salt, and raw materials for paper industry have also been considerably affected. In respect of the manufacturing capacity, minerals (other than salt) and seaports India's loss has been negligible.

One fact, however, stands out prominently from the above discussion. India and Pakistan cannot make progress without each other's help. If India needs Pakistan's raw jute, Pakistan needs India's coal, cotton cloth and other manufactured articles.

CHAPTER 1

Geographical Background

India (also called as Bharat) is distinctively aloof from the main continent of Asia because of the Himalayan ranges in the north and sweeping seas on its remaining 3 sides. This aloofness gives India an entity of its own, remarkable in geographical factors and environs. Crowned by the Himalayas on the north the country stretching to the south, tapers off and meets at a point known as Kanyakumari or the

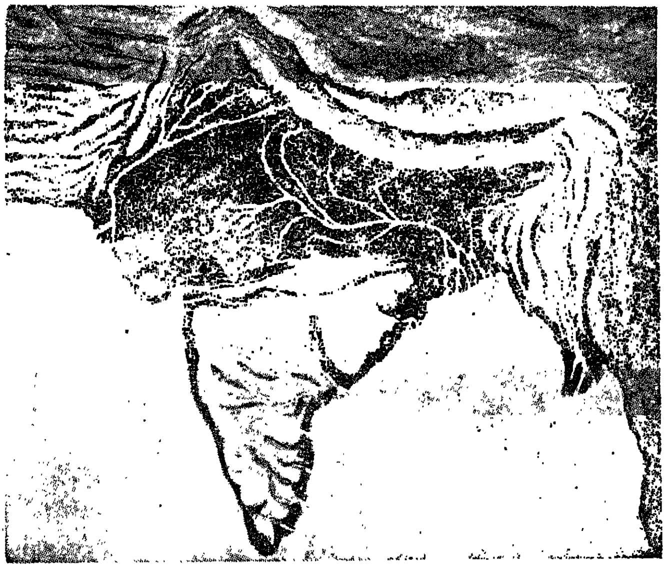


Fig. 1. India and adjoining countries—Physical Features.

Cape Comorin. India lies wholly in the Northern Hemisphere extending from Latitudes 8°4' 28" and 37°17' 53" north and longitudes 68°7' 3" and97°24' 47" east, dimensions being nearly 3219 km. miles from

North to South and about 2977 km. from east to west covering an area of 32,76,141 Sq. km.[2] approximately it ranks 7th largest country in the world. Its coastline stretches for 5,689 km. while the land frontiers constitute a total of 15,168 km.

PHYSICAL FEATURES

The core of the physical structure of India is the Peninsular India. The Peninsular part is the oldest, while all other parts were formed around it at a later period. It is of interest to note that Peninsular

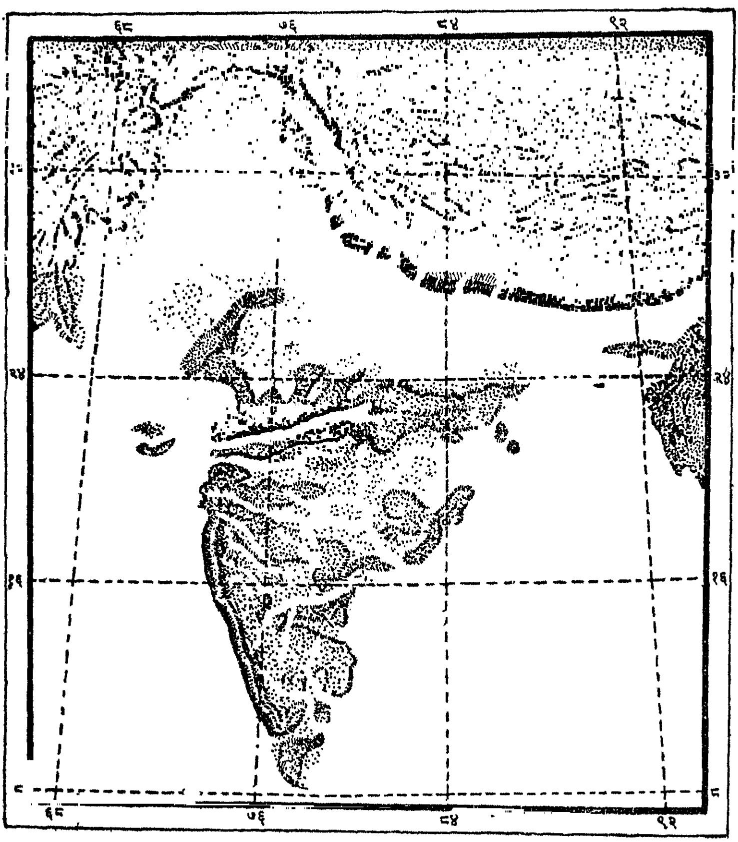


Fig. 2. The Deccan or the Southern Plateau.

India has mostly remained a land area, never having been submerged completely beneath the sea except locally and, that too, temporarily.

2. Including Sikkim (7,107 sq. kms.)

The only structural changes that have taken place here, therefore, have been of the nature of faults or fractures in the crust due to tension. The mountains found in the Peninsula are, therefore, mostly of the "relict" type. They are not true mountains of upheaval, but are mere outstanding portions of the surface that have escaped the weathering of ages that has removed the surrounding parts of the land. Due to its old age one encounters, not the 'youthful', as is characteristic of other regions of India, but 'mature' relief in the Peninsula. Its rivers have flat shallow valleys, with low gradients, because their channels have approached the 'grade or the base-level of erosion'.

GEOLOGICAL HISTORY

There are two periods in the geological history of India which are landmarks in the physical features of the Peninsular India. The first period is that when, owing to earth movements, numerous cracks and fissures were made in the surface and large linear tracts subsided. This gave rise to basin-shaped depressions usually known as the 'Geosyncline'. The drainage of the land discharging its sediments into these depressions ultimately filled them up. These sediments later hardened into rocks known in Geology as the 'Gondwana' rocks, from the typical deposits of these rocks occurring in the Gond country to the south of the Narbada. Beneath this debris was buried the luxuriant vegetation which was later converted into thick seams of coal, in some parts 20 to 80 ft. (6.1 metres to 24.4 metres) thick. There is evidence enough to support the geologists in their conclusion that at this period of the geological history of India the Peninsular India was connected with such far-off countries as Australia and Tasmania, South Africa and Madagascar and Patagonia and Falkland Islands.[3] It was during this period that large deposits of sandstone found in the Mahadeo and other hills of the Satpura range were made.

The second outstanding period is that when the Deccan experienced intense volcanic activity. A large area of the Peninsula was flooded by quiet outpourings of lava from fissures in the earth's surface. The lava eventually raised the greater part of the Peninsular India into a plateau. Denudation has now cut this plateau into numerous isolated, flat-topped and square-sided hill masses, so characteristic of the Western Ghats.

The parts north and east of the Peninsula have had a chequered history. They have been buried under the sea several times. This sea was an extension of Mediterranean Sea and extended at one time up to the south-west corner of China. The geologists call it the Tethys. The mighty Himalayas have been formed from marine deposits in that sea. After the Deccan had been covered with large deposits of lava,

3. This whole southern continent wss known as the 'Gondwanaland'.

it appears that considerable earth forces were released which gradually crumpled and folded the marine deposits of the Tethys into the loftiest mountain of the world, the Himalayas. The sea receded to the west, giving place to an estuary of the combined Indus-Ganga-Brahmaputra river system. The drainage from the newly created Himalayas carried with it immense quantities of debris which quickly filled up this estuary. The forces of upheaval continued and this deposit of the rivers was folded into the Siwaliks near the foot of the Himalayas.

The earth forces involved in the upheaval of the Himalayas produced a depression to the north of the Peninsula. This wide trough between the Peninsula and Himalayas was occupied for some time by an arm of the sea. It was in this trough, therefore, that the drainage from these two areas emptied itself. This drainage was disturbed in later times by unequal earth forces which dismembered the old river system into the three separate river systems of the Indus, the Ganga and the Brahmaputra. The depression which was still left, began to be filled up by the silt brought down from the high ground by the numerous tributaries of the Indus and the Ganga. Each fresh uplift of the mountains must have rejuvenated these streams. This must have multiplied their cutting and carrying capacity, and so quickly filled up the Indo-Gangetic depression. The depth of the alluvium in the Indo-Gangetic depression is tremendous. It is estimated from 6,500 feet to 15,000 feet (1982.5 metres to 4575 metres). The trough is not of uniform depth along its whole length; it is probably at its maximum between Delhi and the Rajmahal hills, and shallowest in Rajmahal and Assam.

Some geologists, however, believe that the Indo-Gangetic Basin occupies not a trough created during the folding of the Himalayas, but a fault valley of the type of the present Narbada valley, which must have been filled up completely by the tremendous amount of silt brought down from the Himalayas. The great depth of the silt deposits must be hiding the steep sides of the fault valley.

The forces of upheaval are still at work in the Himalayas. The northern-rim of the trough where it merges into the Himalayan foothill zone is one of considerable tectonic strain. The earthquake zone of India runs along the northern edge of this trough.

PHYSICAL DIVISIONS

Based upon this geological history, India is divided into the following four physical divisions. In these divisions, the fundamental importance of the Deccan Plateau and of the Himalayas is to be noted. It is along these regions that the plains of India, which are so important economically, have been formed. These physical divisions are :—

1. The Himalayas and the adjacent mountains which surround the plains in the west, north and east;

2. The Southern Plateau, sprawling to the south of the Vindhyan mountains—a solid and stable block, or of earth's surface which has been denuded into a number of mountain ranges, plateaus, valleys and plains.

3. The Sutlej-Ganga Plains, flat and fertile extending from the Punjab to Assam.

4. The Coastal Plains.

Each physiographic region possesses an ethnic character of its own, and has contributed a distinct element to the making of the Indian nation and its civilization.

1. The Himalayas

The mountain mass that bounds India on the land border of Asia consists of a number of mountain ranges among which Himalayas are the most famous. The Indus and the Brahmaputra rivers divide this mountain mass into three sections : (i) the Himalayas, (ii) the mountains lying to the north-west of the Himalayas, and (iii) the mountains lying to the south-east of the Himalayas. Between the Indo-Gangetic plain and the main mountain mass lie minor ranges like the Salt Range and the Siwaliks. Enclosed behind these minor ranges are high plains which are known in some parts as 'Doon plains'.

The Himalayas are a range of folded mountains running from the Pamir-knot in the north-west to the border of Assam for 1,500 miles (2414 kms.) which are among the youngest in the world : because of their youth they have the highest Peak in the world. Mount Everest 29,028 ft. (8848 metres), Kanchinjunga 28,146 ft. (8580 metres), Dhavlagiri 26,826 ft. (8177.7 metres), Mt. Godwin Austin 28,250 ft. (8611 metres), Nanda Devi 25,645 ft. (7818 metres), and Gosainthan 26,305 ft. (8018 metres). These may be compared with Mt. McKinley 23,100 ft. (7041 metres) the highest peak in the Rockies in North America Aconcagua 23,000 ft. (7010.40 metres), the highest peak in the Andes in South America and Mont Blanc 15,781 ft. (4810 metres), the highest peak in the Alps. There are more than 140 peaks in the Himalayas which are higher than Mont Blanc the highest peak of the Alps. The Himalayas have acted as a cilimatic barrier by keeping the Monsoons in and shutting the cold northerly winds away from India, and as commercial and social barrier because of their very high passes.[4] The high altitudes limit travel only to a few passes, notably Jelep La and Natu La. The other passes are Rohtag, Bara Lapcha and Jojila. The average height of these passes in the Himalayas is between

4. "For ages natural barriers of high mountain walls and stormy tropical seas have largely protected India from the influence of the rest of Asia"—Clewell and Thompson, *Land and People*, Vol. IV ,p. 82.

16,000 and 18,000 feet (4877 metres and 5486 metres) which easily exhausts both man and beast. Compare this with some of the important passes in the Alps. The Brenner pass between Italy and Austria is 4,484 ft. (1367 metres). The Simplon between Italy and Switzerland is 4,484 ft. (2010.1 metres) high and the Mont Cenis pass, between Italy and France is 6,850 ft. (2009 metres).

The Himalayas proper extend for about 2414 kilometres (1,500 miles) between the rivers Indus and the Brahmaputra. The average breadth of the country over which they spread, is about 214 kilometres (150 miles). Over this vast extent, ridges and valleys occur in almost all directions. The main folds, however, all run along the Tibetan Plateau. In the north-western section, therefore, the general trend of the valleys is east-west, and in the eastern section it is north-south. There is no continuous valley to separate the main range from the minor ones. Owing to their youth the Himalayan valleys are mostly V-shaped narrow gorges in which the streams are cutting backwards, so that river and valley capture is a very common feature in the Himalayas. Some U-shaped glaciated valleys also occur at great elevations where the glaciers descend from the mountains.

Longitudinal Description of the Himalayas

The Himalayas can be divided longitudinally into four zones, parallel to each other :—

1. *The Trans-Himalayan Zone*, about 40 km. in width, containing the valleys of the rivers rising behind the Great Himalayas.

2. *The Great Himalaya* or Central Himalaya, comprising the zone of high snow-capped peaks which are about 128 or 144 kilometres from the edge of the plains. The Great Himalayan range, running from the Indus to the Brahmaputra, is characterised by great elevations which remain covered under perpetual snow. The highest snowy peaks of the Himalayas occur in this range *e.g.*, Mount Everest (8848 metres), Kanchinjunga (8580 metres), Dhaulagiri (8177 metres), Mt. Godwin Austin (8611 metres), Nanda Devi (7818 metres) *etc.*

3. *The Lesser Himalayan Zone*, 64 to 80 kilometres wide and of an average altitude of about 3000 metres. This consists of parallel ranges in Nepal and Punjab but of scattered mountains of Kumaon and Uttarakhand. The zone between 1500 to 1600 metres is covered by evergreen and oak forests and that between 1600 to 2124 m. by coniferous forests of chir, deodar, the blue pine, oaks and magnolias, whereas above 2436 metres are found birch, spruce, silver fir and other species

4. *The Siwalik Foot Hills* which are not a continuous range like the Himalayas or the other ranges are a mere two to three thousand feet as compared with the staggering heights of the Himalayas ranging in the neighbourhood of 8534 metres. These hills have been made out of the debris coming from the Himalayas. The proportion of mud, therefore, predominates in these hills, which accounts for the particularly green aspect of the Siwaliks. These hills are found only in the middle section of the Himalayas. They are absent in its north-western and eastern sections. The Siwaliks are given different names in some parts, for example, near Gorakhpur they are known as Dundwa Range and further east as Churia Range.

Between the Siwaliks and the Himalayas there are some flat valleys known in some parts as Duns. Hence the name Dehra Dun *etc.* The Duns are covered with deep deposits of silt and rock brought down by the swift-flowing rivers from the Himalayas. These rivers, in most cases, are obstructed in their course by the Siwaliks. They, therefore, deposit a considerable part of their load in the plains lying between the foothills of the Himalayas and the Siwaliks, here and there in these Duns jut out the tops of hillocks that have been buried under the silt. Usually these tops are well wooded. In most cases rivers cross the Siwalik hills through deep gorges, but in some cases large rivers also flow out through the gaps naturally provided by the

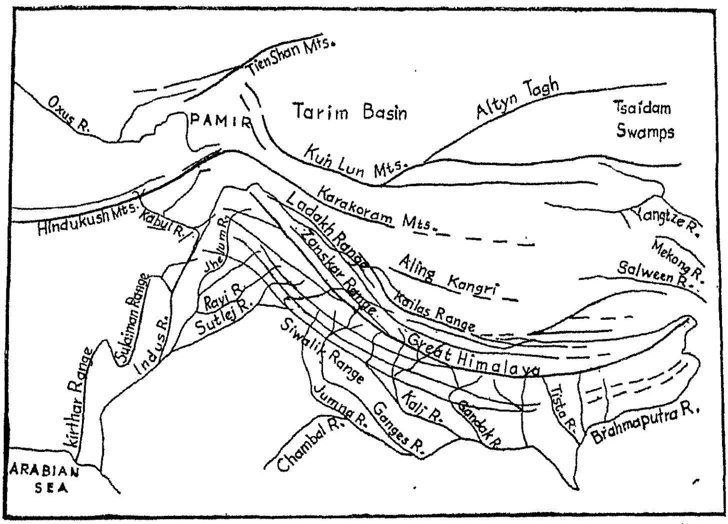


Fig. 3. Longitudinal Distribution of the Himalayan Range

occurrence of these hills in sections. Figure 3 shows the longitudinal distribution of the Himalayan ranges.

Western off-shoots. Towards north-west beyond Indus, Himalayas are succeeded by mountainous country of Baltistan. Karakoram and the Hindukush mountains dominate this part. This mountainous country continues westward into the tribal homes of the border tribes living between Pakistan and Afghanistan. The Sulaiman and the Kirthar ranges separate this hilly country part of which lies in the North Western Frontier Province and in Baluchistan, from the Indus Plains. Separated from the Indus plains by the Sulaiman Range are almost hill-girdled plains of Peshawar, Kohat and Bannu situated at an altitude of more than a thousand feet. These plains are similar to the 'Doon' plains found between the Siwaliks and the Himalayas in India : the place of the Siwaliks being taken by the Salt Range to the south of Peshawar plain in Pakistan.

The slope of the mountains is steep towards the Indus plains and communication is possible only through the mountain passes that follow one or the other stream crossing these mountains from Afghanistan side. The most important of these passes is the Khyber pass that follows the Kabul river which is the biggest river coming from across these mountains. These passes are situated at about six thousand feet above sea-level and are not so difficult to cross as the high Himalyan passes.

The direction of valleys in this hilly region is generally from north-east to south west, which further west in Makran becomes east-west. As one proceeds away from the Himalayas in this hilly country, the climate becomes drier and drier. The land forms are, therefore, more and more the result of wind erosion. Alluvial deposits are less marked. Stony ground predominates.

Eastern off-shoots. Towards east, Brahmaputra breaks the continuity of Himalayas into the adjoining hills of Burma and Assam. These hills are not so high as the Himalayas or even those on the North-Western Frontier in Pakistan. There are no broad valleys in these hills. The *Garo*, *Khasi*, *Jaintia*, and the *Naga hills* running almost east-west join the chain of the *Lushai* and the Arakan hills running north-south. Towards the plains these hills generally present a steep slope. Towards the interior of this hilly region the slope is gradual and there are some plateaus broken by low hills. One such plateau is the *Plateau* of *Shillong*. In the south in some places the hills have receded a little giving the shape of a funnel. Cherrapunji which has got the distinction of having about the largest rainfall in the world, is situated in one of these funnels. The plains in the neighbourhood of these hills are generally swampy due both to the heavy rainfall and a flat muddy surface which retards quick drainage

All along the Himalayas and other hilly regions where they join the plains, there are 'forelands' known locally as *'bhabar'* or *'ghar'* in which are deposited coarse sands and pebbles brought down from the hills by the swift-flowing mountain streams. Except during the rainy season these areas are marked by dry river courses in which the water of the smaller streams sinks underground. It is only the larger rivers that flow on the surface in the *bhabar* area. These *bhabar* lands are more extensive in the western and north-western hilly region than in the east.

The water that sinks underground in the bhabar reappears on the surface where the plains begin. This water converts large areas along the water parts of the hilly regions into *'swamps'* or *'terai'* (no man's land) which is usually an ill-drained, densely forested plain. The terai is more marked in the eastern regions, due to greater rainfall than in the west.

Regional Distribution of the Himalayas

The Himalayas has also been divided by Sir Sidney Burrard into four transverse regions, *viz.*,

The Punjab Himalaya

The Kumaon Himalaya

The Nepal Himalaya

The Assam Himalaya

The Punjab Himalaya, 560 kilometres long, is the portion between the Sutlej and the Indus. The Sutlej cuts across he Himalaya where it shows a marked curvature. The main range carries few peaks exceeding 6,000 metres. Between the Great Himalayan range and Southern minor ranges lies a longitudinal valley with a South-east to north-west trend, some 134 kilometres long and 40 kilometres broad in its middle, the broadest part. The Kashmir Valley itself may be taken as an exaggerated instance of a dun in the middle Himalaya. In the Jammu hills the extensive, picturesque duns of Udhampur and Kotli are quite typical. The origin of these may have been the silting up of great lakes, the evidence of which may be found, in the case of Kashmir, in the remnants, the Wular lake and the two Dals near Srinagar.

The Kumaon Himalaya, 320 kilometres long is the portion between the Sutlej river on the west and the Kali on the east and is crowned by many important peaks. In the following table I heights are shown—

TABLE 1 : *Height of the important Peaks in Kumaon Himalaya*

Nanda Devi	7818 metres
Badrinath	7040 ,,
Kedarnath	6831 ,,
Trisul	6707 ,,
Mana	7158 ,,
Gangotri	6508 ,,
Jaonli	6527 ,,

The Nepal Himalaya, from Kali to Tista and is 800 kilometres long. The region is crowned by many peaks of perpetual snow. Their average height extends to 6850 metres, on it are situated the peaks, like Mt. Everest, Kanchinjunga *etc.* In the following table II heights are shown—

TABLE 2 : *Height of the important Peaks in Nepal Himalaya*

Mount Everest	8848 metres
Kanchinjunga	8580 ,,
Dhaulagiri	8177 ,,
Gosainthan	8018 ,,
Annapurana	8050 ,,
Makalu	8190 ,,

The Assam Himalaya, from Tista to Brahmaputra is 720 kilometre long. The Kula Kangri group of peaks (7250 metres) and Chomokhari occur in this portion. The Himalayan ranges in Assam rises very rapidly from the plains, the foot hills region being narrow and the Sub-Himalayas comparatively lower in altitude than in other areas.

The Peninsular Region which is the oldest part of India, is divided into several large or small plateaus, about 610 metres (2,000 ft.) above sea level. The dividing line is formed by low hills, which are either the remnants of old mountain systems, as in the case of the Aravalli Hills, or the harder parts of the plateau itself which have withstood erosion, as in the case of the Western Ghats. The interiors of the plateaus are marked by a number of rivers which flow in broad, flat valleys. The fringes are considerably broken. On the top, the surface of the plateau is hammocky or undulating. A number of isolated hillocks are also found in the interiors, but they are more numerous near the hills bounding the plateaus.

The fault or the rift, in which the Narbada river flows, divides the Plateau Region into two almost triangular portions. The northern portion is known as the *Malwa Plateau* and the southern the *Deccan Plateau*. To the west and north-west of the Malwa plateau are the Aravalli Hills which occupy a considerable east-west expanse. They narrow down considerably towards the north-east where they degenerate into low hillocks which finally end near Delhi. The *Aravallis* are crossed by a number of rivers which are dry except during the rainy season. Important among them are the Mahi, and the *Luni* flowing into Arabian Sea, and the *Chambal* with the *Banas*, flowing into the *Jamuna*. The highest elevations of the Aravallis occur in the north-eastern section in the isolated blocks, where Mount Abu is the highest point, 1714 metres (5,653 feet) above sea level.

In Rajasthan the vicinity of the Aravallis is marked by patches of stony ground which are evidence of the long time during which erosion has been going on in the Aravalli area. It has already been noted that the Aravallis are the remnants of the oldest mountain system of India.

Towards the south, the Malwa plateau is bounded by the Vindhyas which are given the high-sounding name of 'Mountains', though in reality they are nothing more than the escarpment of a rift valley. Running east-west along the Narbada valley, the Vindhyas join the Kaimur Range which is a similar escarpment along the Sone valley. Towards the north-eastern corner of the Malwa Plateau are the *Bundi hills*. The Malwa Plateau, like the other plateaus in the south, is largely broken in the neighbourhood of rivers or where it approaches the Ganga Valley. These broken areas are called 'ravine land'. Examples of these ravine lands are found in the highly broken country of Bundelkhand and in the valleys of the Chambal and the Banas. In the interior the surface is flat, except where isolated low hillocks occur. The slope of the greater part of the Malwa plateau is towards the Gangetic valley.

The country south of the Narbada is called 'the Deccan' tableland. It is also triangular in shape and bounded by low hills on all sides. Towards the north are the Satpura hills whose highest point is in the Mahadeo Hills, on which is situated Pachmarhi, the summer seat of the M. P. Government. These hills continue towards the east where they meet in the Amarkantak, the hills of the Chhota Nagpur plateau. There are various local names given to the hills. One distinct feature of the Satpuras and other hills of the Deccan tableland is that unlike the Himalayas, they have no conical 'peaks', they have 'flat tops' or small table lands as their highest point. The *Satpuras* have experienced in the past much faulting, as a result of which practically all the rivers in it flow in deep gorges. The gorges are big or small according to the

size of the rivers which have considerably modified these gorges. The descent of these rivers from the higher plateau is by means of falls, as in the case of the Narbada near Jabalpur. Towards the north of

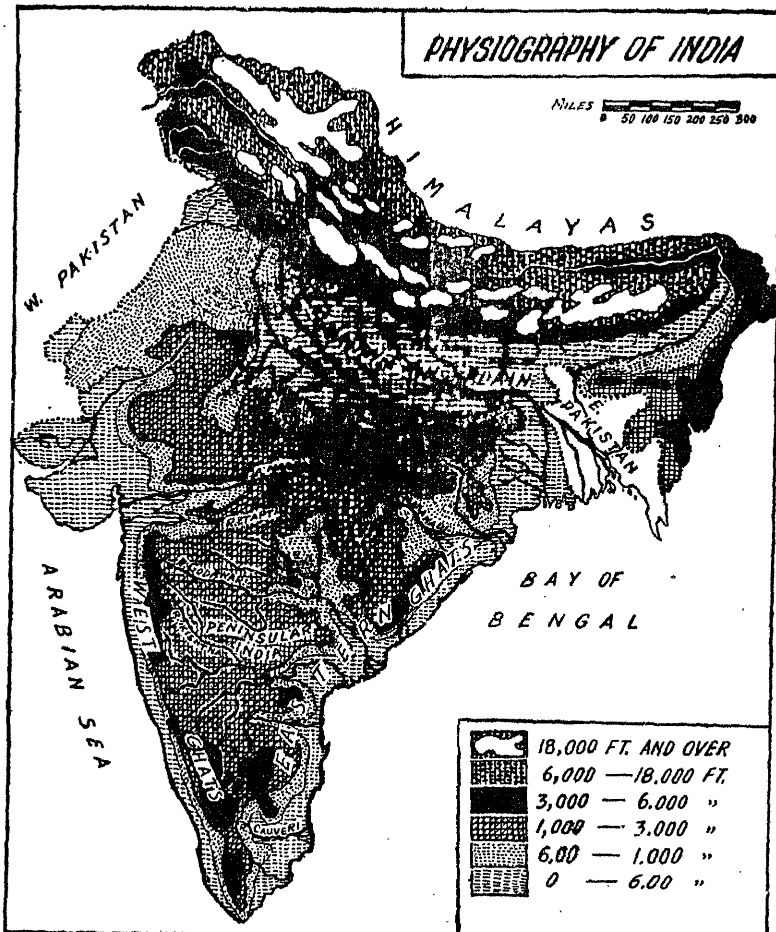


Fig. 4. Physiography of India

the Satpura lies the fault valley of the Narbada and towards the south that of the Tapti. The flat plains of the Narbada and the Tapti lie in the region of the 'regur' or the 'lava soil' in which the rounded tops of a few hillocks buried under the deep lava deposits protrude here and there. The rivers Narbada and Tapti flow against the general slope of the tableland due to their situation in deep rift valleys running east to west.

The western flank of the Deccan tableland is guarded by the Western Ghats, a portion of them is also called the Sahyadari hills. They are 914 metres or (3,000 ft.) high. Their steep slope is towards the sea. The wall-like slope of the Western Ghats towards the Arabian Sea is a clear indication of faulting which seems to have separated the Peninsula of India from the land that now lies buried under the Arabian Sea. The Western Ghats are a continuous mass running north-south, across which access is possible only through a few gaps or low passes. In two of the passes, the *Bhor Ghat*, and the *Thal Ghat*, access is through tunnels. Except near their northern and the southern extremities, the Western Ghats run close to the sea leaving only a very narrow coastal strip. Where they are very close to the sea, rocks jut out into the sea making navigation risky. Only a few rivers have been able to cut

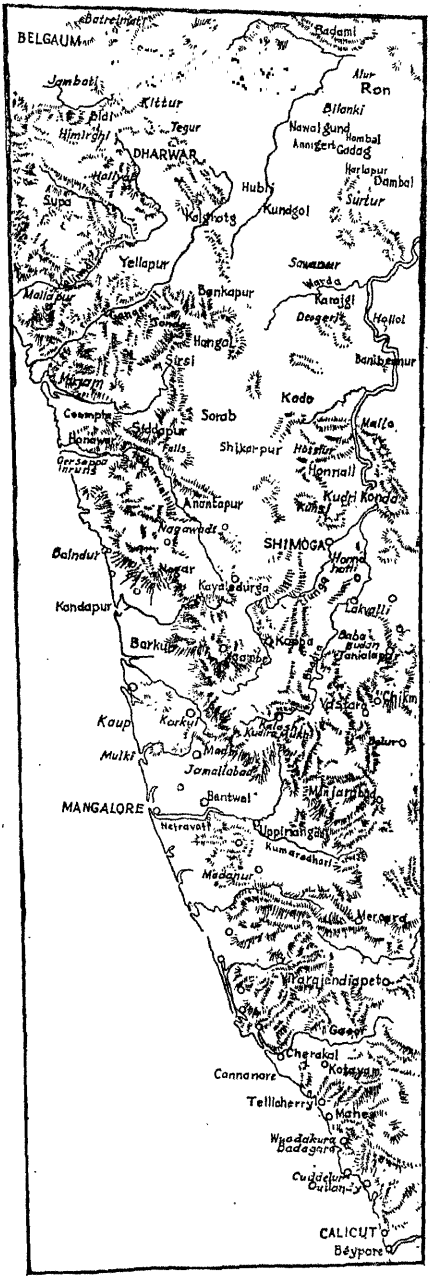


Fig. 5. Western Ghats and the Tablelands.

their course across these hills : they all flow through very deep gorges along which communication is impossible. There are many rivers that take their rise on the western slope and many others on the eastern slope. Those on the west have a shorter distance to the sea and are, therefore, swift-flowing, with small alluvial fans near their mouth and water-falls in their lower courses. Those on the east have longer and, in their lower courses, wider valleys with big deltas near their mouth. Usually there are big falls where these rivers descend from the Ghats to the plateau to the east or the coastal plain to the west.

Towards the east of the tableland are the Eastern *Ghats* which are in contrast to the Western Ghats just described. The Eastern Ghats are a series of low hillocks about 456 metres (1500 ft.) high separated from one another by wide gaps usually occupied by rivers coming from the Western Ghats or the Satpuras. It is only in the extreme south where they join the *Nilgiri Hills* that they are continuous for some distance. The Eastern Ghats are the remnants of very old fold mountains like the Aravallis. They are unlike the Western Ghats which are an escarpment of the Plateau. They do not rank with the Western Ghats in height or steepness of slope. Towards the north-east, the Eastern Ghats join the hills of the Chhota Nagpur plateau. Throughout their extent the Eastern Ghats keep away from the sea, thus leaving a broad coastal strip. It is only near the Chilka Lake that they approach closest to the sea. The Eastern Ghats are joined to the Western Ghats through the Nilgiris and to the Satpuras through the Chhota Nagpur hills, thus completing the triangular boundary of the tableland.

South of the Nilgiris lie the *Annamalai Hills* which are separated from the former by the *Palghat Gap*. This gap is about 32 kms. or (20 miles) broad and provides easy access between the west and the east coast of India. A branch of the Annamalai runs to the north-east under the name of *Palni Hills*. Another branch runs to the south as the Cardammom Hills. The latter continue right up to the southern extremity of the country.

Thus the physical features of the Peninsular India have resulted partly from the very old mountain systems that remain exposed above the vast lava deposits, and partly from the lava deposits themselves that buried the old rocks to a great thickness converting the major part of the peninsula into a big tableland or plateau.

The remnants of the old mountain systems in the Peninsula are the *Aravalli*, the Satpura and the Eastern Ghats. These are mostly disconnected hills with rounded or flat peaks. Their elevation is generally low. They are formed largely of old sand-stone, though limestone and shales are also of common occurrence in them. The Peninsular region of India has experienced a good deal of 'faulting' in the past. Owing to this faulting several large "Sag faults" have been

formed. Some of these faults are now occupied by rivers, *e.g.*, the Narbada and the Tapti rivers. The result of this faulting has been that the big plateu of the peninsula has been divided into a number of small plateaus; like the Malwa plateau, the Deccan tableland, the Chhota Nagpur plateau and the Mysore plateau etc. The escarpmenst facing the valleys that separate these smaller plateaus are considerably broken up into ravines due to the erosive action of running water. They therefore look like hills when seen from the valley itself. The Vindhyas, the Kaimurs and the Bundi Hills are examples of such dissected escarpments.

The highest peak of the *Nilgiris*, *Dodabetta* is over 2623 metres or (8,640 ft.) of the Annamalai the highest peak is *Anaimudi* over 2682 metres (8,800 ft.). These mountains are the continuation of the Eastern Ghat mountains.

The tops of the plateaus are seldom flat. They are generally hammocky or undulating. Here and there stand a few hillocks which are the evidence of the harder parts of the plateau resisting erosion for long. Some of these hillocks like the Fort rock of Gwalior are the examples of 'circum-erosional mountains' which stand out above the surrounding country because the softer rocks around them have been washed away. The rivers that flow in these plateaus have cut for

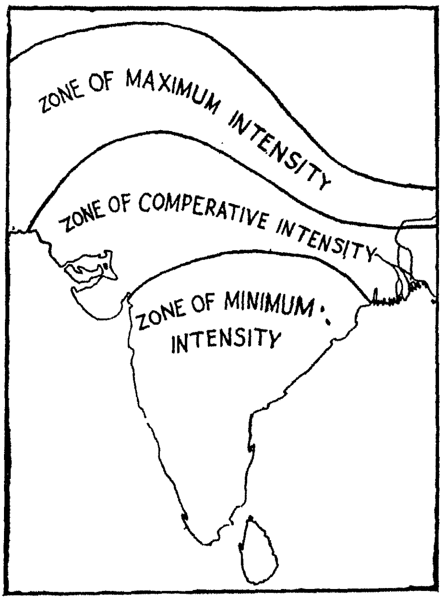


Fig. 6. Intensity of seismic evidence in India.

themselves deep and broad valleys with almost flat bottoms. Where these rivers leave the plateaus there are generally waterfalls or rapids.

The most conspicuous feature of the Peninsula is, however, provided by the Western Ghats. They are a considerably eroded escarpment of the lava plateau facing the Arabian Sea.

The Peninsular India is marked by old and hard rocks which are mainly metamorphosed rocks like the Dharwar rocks; igneous rocks like the granites and basalts that usually occur as loose isolated blocks; and old sedimentary rocks like the sand-stones and limestones. The basalt rock also occurs as a black thin layer on the tops of hills.

The rocks of the Peninsula have suffered long denudation. This part of India, therefore, tends to be a plateau, as the elevations have been worn down. The lava deposit over a large section to a great depth also made it a plateau.

The Peninsula is a region of great geological stability and is remarkably immune from seismic disturbances of any intensity. Figure 6 shows the intensity of seismic evidences in India.

In conclusion it may be said that there is a great variety of physical features in peninsular India. Though this plateau is poor in forest resources yet it is rich in minerals and is regarded as the 'store-house of minerals'.

3. The Sutlej-Ganga Plains or The Great Plains of India

The Sutlej-Ganga plains appear flat with a gentle slope away from the Himalayas. These plains are wholly composed of sediment deposited by great rivers of northern India. The great depth of the alluvium has made this plain very fertile. No rock-bed is disclosed by boring done from 152 metres to 305 metres (500 to 1000 ft). According to Oldham the maximum depth of the soil in this plain is about 4572 metres (15000 ft.) near its southern edge. The deposits include a great thickness of clay, loam and silt. For kilometres together they show no relief features. On closer examination, however, hey are found to be cut up into a number of lowlands and uplands formed by the numerous rivers coming from the Himalayas. The older alluvium deposited by the rivers forms the uplands which are known locally as "*Bangar*", and the newer alluvium in the riverbeds forms the lowlands or '*Khadir*'. The older and the newer alluviums are separated from each other by the high river banks which are in some cases as high as one 30 kilometres from the riverbed. The uplands in the neighbourhood of rivers are broken into extensive ravine lands, extending for kilometres on both sides of the rivers. The ravine lands are like the 'bad lands' of Western plains of NorthAmerica and have

suffered considerably from soil erosion due to reckless destruction of vegetation cover of the soil.

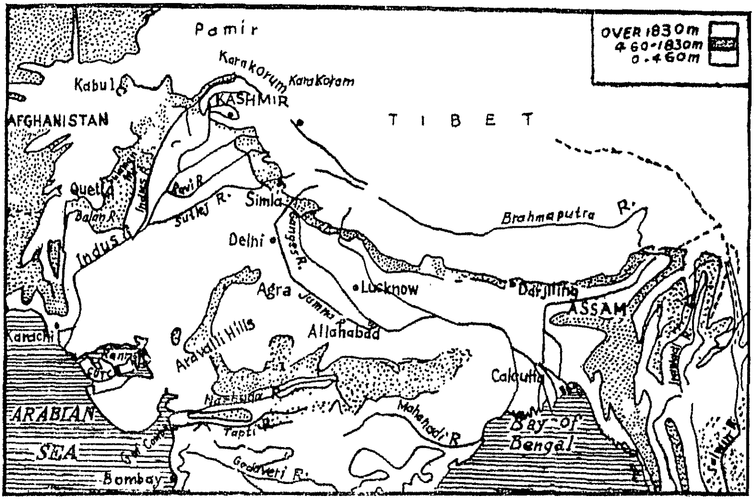


Fig. 7. Indo-Gangetic Plain.

The lowlands and depressions become more prominent as one approaches the delta of the Ganga. The Ganga Delta is the largest delta in the world having an area of about 51,306 kms. (31880 sq. miles). A large number of the depressions in the lower section of the Ganga plain are old river beds which have been cut off by a change in the river course. These depressions are called locally the 'bils', while the river banks are called *Chars*. The significance of the 'Chars' is very great in the location of villages in the delta region where the depressions are entirely flooded during the rainy season.

Origin of the Plain

The geological evolution of the plain remains a matter of discussion.

Eduard Suess, the Austrian geologist, suggests that the plain constituted a "foredeep" in front of the high crust waves of the Himalayas as in their southward advance they were checked by the inflexible solid land mass of the peninsula. The rivers rising from the Himalayas brought an immense amount of detritus and deposited it in this depression. The deposition of the Alluvium continued throughout the Pleistocene period up to the present and led to the formation of the plain.

The observations of S. Burrard and other geodetic consideration present a perfectly new and different concept which is quite different from the concept of Edward Suess. S. Burrard considers this region to be a great "deep rift" or fracture which has become filled up by the river-brought alluvium. But the Geological Survey of India does not accept this concept.

According to Blanford the Indian peninsula, during the Eocene times, was a part of a continent which was connected with Africa. During this period a sea lay in its east form the valley of Assam upto Irrawaddy river. During this very epoch, another sea was lying in the north-west from Iran and Baluchistan in the west upto Ladakh in the Indus Valley. This sea spread itself upto Punjab during the later Eocene times but with the approach of Miocene period this sea gradually began to diminish, with the uplifting of the Himalayan ranges.

The most important and more recent view regards this region as a sag in the crust formed between the northward drifting Indian continent in the South and the comparatively soft sediments accumulated in the Tethyan as well as in the connected basins on the north. The crumpling of the sediments resulted in the formation of a mountain system.

It should be noted that no part of the Indo-Gangetic plain is "peneplain".

4. Coastal Plains

The Southern Plateau is surrounded on all sides by low plains. It is against the hard rocks of the plateau that the plains have been formed. Towards the north is the Sutlej-Gangetic plain; towards the east the Gangetic plain and the eastern coastal plain; towards the south also the eastern coastal plain; and towards the west, the western coastal plain which joins the Thar desert plains.

The Eastern Coastal Plain, which is known as the *Payanghat* may be considered in two sections : The lower section which consists of the deltas of the rivers; and the upper section which consists mostly of the plains lying in the upper courses of the rivers. The lower section is entirely alluvial, while the upper section is partly alluvial and partly a Peneplain formed by the denudation of elevated relief. This Peneplain is covered in some places by thin alluvium of the river, while elsewhere old rocks still stand out prominently. The lower section is fringed by a series of sand dunes in the vicinity of the sea. These sand dunes have been formed by the action of waves. In some parts enclosed within these sand dunes are lagoons. The lakes *Pulicat* and *Chilka* are in reality big lagoons of this type. Immediately along the sea a sandy beach stretches all along the sea coast. The Payanghat extends through the Palghat gap to the western coastal plain.

The Western Coastal Plain, beginning from the Malabar coast runs from the south to the north all along the Arabian Sea. Towards the south the plain is very narrow about 64 kms. (40 miles) except where the Western Ghats have receded. The southern section is also characterised by a number of long and narrow lagoons which are navigable for hundreds of miles. These lagoons are unlike those found on the eastern coast in this respect because the latter are generally surf-beaten and shallow which are joined by canals, which serve as good coastal traffic by boats, rafts and canoes. The western coastal plain broadens to the north of Bombay into the alluvial plains of the Tapti and the Narbada, and further north into Gujrat. Part of the coastal plain in Gujrat ad Kathiawar, as well as in Cutch, is also a "*Peneplain*" where the old rocks still appear on the surface. Gujrat and Kathiawar plains are partly covered by the regur of the Black Cotton Soil. The monsoon floods being enormous silts help the growth of enormous forests and plantations.

The western coastal plains merge in the extreme north into the Thar and Rajasthan deserts. These parts are characterised by vast deposits of sand or silt partly due to the dry old river courses and partly to the emergence of vast plains from under the sea which is receding in this part.

The Thar and Rajasthan deserts, in their western and northern sections are marked by sand dunes covering hundreds of square miles of area. These sand dunes are due generally to the blowing in of sand from the neighbouring dry plains by the prevailing winds.

Drainage System

Much of the Northern Plain of India is the gift of the two rivers, the Ganga and the Indus (now in western Pakistan). The Ganga, Indus and Brahmaputra rise near each other in the Himalaya. The Ganga rises on the Southern side, the Indus and the Brahmaputra on the northern. Near the source of Ganga rises its tributary the Jamuna; both flow in parallel course through rocky gorges to the plains.

For centuries the 2400 kilometres of Ganga was the chief road and the one source of wealth to the farmers. At its mouth in the Bay of Bengal it is joined by the Brahmaputra. Together they form a big swampy delta called Sundarbans which is overrun with jungle plants, wild animals, and malaria.

The Ganga Basin is the largest receiving water from an area which comprises about one-quarter of the total area of India. Its boundaries are well defined by the Himalayas in the north and the Vin-

dhyan mountains in the south. The Ganga has two main headwaters in the Himalayas—the Bhagirathi and the Alaknanda, the former rising from the Gangotri glacier at Gaumukh. The Ganga is joined by a number of Himalayan rivers including the Yamuna or Jamuna, Ghaghara, Gandak and the Kosi. Of the rivers flowing north from Central India into the Yamuna or the Ganga, mention may be made of the Chambal, Betwa and Sone *etc.*

The Brahmaputra flows through Tibet, NEFA, Assam, and then through Eastern Bengal.

The Indus, like the Brahmaputra, flows for many kilometres through narrow and deep defiles and gloomy gorges of little use for men or farming. Then it turns south and flows through the fertile pleasant vale of Kashmir; and afterwards with five tributaries crosses the north-western part of the Northern Plain of India. Sutlej is the main tributary of Indus. The land of the Sutlej and its feeding rivers is called the plan Punjab or "Land of five Rivers" (Panchanad).

The river system of the Peninsula, omitting the drainage into the Ganga and small streams flowing to the west coast, is nearly all taken by six large rivers, of which two, the Narmada and Tapti, drain the north-western portion and escape into the gulf of Combay, while the drainage of all the rest of the Peninsula even from the crests of the Western Ghats within sight of the sea, flows eastwards by four great deltaic rivers, the Mahanadi, Godavari, Krishna and Cauvery—the only other streams of any importance being the northern and southern Pennear.

This easterly trend of the drainage is probably of very ancient date, as there are patches of littoral marine deposits along the east coast ranging far back as the close of the Jurassic period, which show that since that period at least, the eastern coast of the Peninsula has maintained very much its present position. On the west coast no marine sediments older than the upper tertiary are known if we except the cretaceous beds of the lower Narmada valley. At the close of the Deccan trap period, that is the commencement of the tertiary era dry land must have extended considerably west of the coast line,. south of the trap area the evidence is only negative, but the absence of any large valleys draining in this direction suggests that the present position of the shore line is of more recent origin that of the east coast and that the earth movements which gave rise to it were either too slow or more probably not of a nature to change the easterly course of the drainage.

The Deccan rivers are generally rain-fed and, therefore, fluctuate very much in volume. A very large numbers of streams are non-perennial. The coastal streams are short in length and have limited catchment areas. The Luni is the only river that drains in the the Rann of Kutch.

Glaciers

The snow-line is at different altitudes in different parts of the Himalayas and associated ranges. In the Eastern Himalaya the snow-line is at about 4200 metres of height whereas in the "Himalaya West" it varies from 5700 metres. In Himalaya there are many Alpine glaciers. Many of them are the transverse glaciers and some of the longitudinal glaciers. But the majority of glaciers in Himalaya mostly belong to longitudinal type. The following table (3) shows the important glaciers in Himalayas.

TABLE III : *Glaciers of Himalayas*

Name	Location	Length Kilometres	Type
Siachen	Karakoram	72	Longitudinal
Hispar	,,	60	,,
Biafo	,,	62	,,
Baltoro	,,	58	,,
Batura	,,	58	,,
Rimo	Punjab Himalaya	40	,,
Punmah	,,	27	Traverse
Rupal	,,	16	,,
Diamir	,,	12	—
Sonapani	,,	12	—
Gangotri [5]	Kumaon Himalaya	25	Traverse
Milam	,,	19	Longitudinal
Kosa	,,	11	,,
Kedarnath	,,	14	Traverse
Zemu	Nepal Himalaya	25	,,
Kanchinjunga	,,	16	,,

The special feature of these glaciers of Himalaya is that most of them are river feeders. Many rivers receive their water from them such as river Pindar from Pindari glacier, Alakananda from Alokapuri Bak, Rivers Bhagirathi from Caumukh (30°50′ 79° 4½′) 28 kilometres upward far from Gangotri glacier and Goriganga from Milam glacier.

5. Gangotri is not the source of river Ganga, the actual source is beyond even Gaumukh which is itself about 28 Kilometres from Gangotri. An Idol of the Holy river is said to have been istalled by Adi Shankaracharya, Gangotri is famous because King Bhagirathi is said to have done long and difficult penitence at Gangotri for bringing the holy river from heaven on this earth.

Volcanoes

India does not furnish examples of volcanic activity in the present age. Dr. Chhibber has mentioned the time of volcanic action in India to be Palaeozoic era. During that geological era volcanic activity might have been active in some parts of India and the volcanic products such as lava *etc.*, might have spread far and wide. At present some of the areas of India contain hot springs. The water from these hot springs always remains flowing but it does not show any kind of explosive action. Hot springs of this kind are found only in those areas where volcanic action was frequent in past ages. Actually speaking they are in the solfataric stage now.

Barren Island in the Bay of Bengal is only a perfect model of dormant volcano. Barren Island has the shape of a cone which is surrounded by an encircling ring of a former crater. It was seen in actual eruption in 1789, 1795 and 1803 ; since then it has been dormant.

One hundred and twenty kilometres north-north-east of Barren Island lies the Island of Narcondam, indubitably of volcanic origin like the former, but composed almost entirely of hornblende andesite lava with little or no volcanic ash. It is not certain whether this volcano ever had a crater, as it may have been of the so-called endogenous type formed by the quit extrusion of lavas unaccompanied by any crater-forming materials.

Further north, in the central belt of Burma, there is evidence of Pliocene and Pleistocene activity in Mount Popa, Shwebo, Mandalay and lower Chindwin districts, and the nighbouring part of Yunnan.

All these old volcanoes lie along a line which, if continued to the South, would be continuous with the general direction of the great chain of volcanoes running through the Islands of Java and Sumatra, and they form the northern termination of what is known as the Sunda chain of volcanoes.

Old volcanism has been fairly wide-spread in the Peninsula and on its shores. In 1756 a Submarine eruption is said to have taken place on the coast of Pondichery which threw up large quantities of ashes and pumice and formed an island half a kilometre long and the same breadth.

A very curious crateriform lake is situated in the interior of the Indian Peninsula near the village of Lonar about 64 kilometres east by north of Jalna in Andhra Pradesh, and about half-way between Bombay and Nagpur. Lonar lake crater is of comparatively recent origin and if so it suggests that in one isolated spot in India a singularly violent explosive action must have taken place unaccompanied by the eruption of melted rock. Nothing similar is known to occur elsewhere in the Indian Peninsula.

Recent change of level along the coast

There can be no doubt that, beyond the limits of the Peninsula, there have been very great changes in the distribution of land and sea since the commencement of the tertiary era and, even in the latest part of it, the great disturbances which the rocks have undergone must have been accompanied by great changes of Shoreline. But when we come to the post-tertiary period, on the whole, there has been elevation or subsidence, the evidence is contradictory. In the alluvium of the delta of Ganga, and near Pondichery beds of peat, at various levels below the surface of the ground, show that there has been subsidence, but this is the usual, if not invariable, condition in a delta, and it is more than probable that all the large deltas along the coast are being gradually depressed.

Along the non-deltaic portions of the coast evidences of sub-recent elevation are found in coral reefs and marine deposits raised above the present level of the sea. The low level laterite of the east coast lies on a gentle slope of the older rocks unaffected by subaerial erosion, such as is formed by the sea, and must have been deposited either before or shortly after this was raised above sea-level.

The escarpment of the Sahyadri range—a remarkable feature of the hills parallel to the western coast of the Peninsula-has frequently been noticed as furnishing evidence of a rise of land. Throughout the trap country of the Maharashtra, the western Ghats rise from the Konkan in an almost unbroken wall, varying in height from 609 to 1220 metres, cut back in places by streams, projecting here and there into long promontories, but preserving throughout a singular resemblance to sea cliffs.

On the other hand, a sudden deepening of the sea, at a distance of 16 to 32 kilometres from the shore, along the Mekran coast, has been supposed to represent a submerged cliff. Most positive evidence of recent subsidence is to be found in the occurrence of a number of trees imbedded of mud, in the spot where they grew, at a depth of 4 metres below low-water mark on the east side of the island of Bombay and in the submerged forest at the western end of the Valimukam Bay on the Tirunelveli (Tinnevelly) coast.

Local alterations of level, accompanied by earthquakes, are known to have occurred on at least one occasion, namely the great earthquake of Kutch in 1819, when a considerable area in the Rann of Kutch was suddenly submerged. A more doubtful instance is the elevation and subsidence which is said to have taken place on the Arakan coast in the middle of the last century, presumably during the great earthquake of 1762. A raised beach which is 3 metres above sea-level at Foul Island and 7 on the north-west of Cheduba island, has been attributed to the effects of this earthquake which further north is said to have caused the permanent submergence of 30 sq. km.

Away from the sea coast, the Andaman and Nicobar Islands have certainly at one time been connected with Arakan, and the intricate Channels and long ramifying fjords which penetrate the great Andaman and adjoining islands indicate a considerable submergence. Along the coast there are, however, indications of minor oscillations of level, both upwards and downwards, within the recent period, the last movement being probably one of subsidence. Off the west coast of India the coral archipelagos of Laccadive and Maldive Islands probably mark the site of submerged land.

Besides the changes produced by rise and fall of the sea-level as compared with that of the land, there have been minor modifications of the shore line due to erosion and accretion of land. St. Thome, a short distance south of Madras, is said to have formerly been situated 36 kilometres inland and 64 kilometers further south, the town of Mahaballipuram is said to have been overwhelmed by the sea.

Evidence of the advance of land is to be found on the Tirunelveli (Tinnevelly) coast. A similar advance of the shore line is said to have taken place on the east coast of the Gulf of Cambay, and it is said that the Rann of Kutch was once a gulf of the sea with sea-ports on its shores and that remains of ships have been found imbedded on the mud.[6] The Rann is now a sort of debateable land, being flooded during the south-west monsoon and a dry barren mud flat during the rest of the year, the change, which has indubitably taken place, if not so recently as has been supposed, was doubtless due to silting up, partly aided by a slight elevation of the land.

QUESTIONS

1. What is the economic significance of the Himalayas ?

2. How do the Siwaliks form the Himalaya ? What is their economic significance ?

3. What is a 'Doon, ? What are its phycisal characteristics ?

4. How do valleys of the Deccan tableland differ from those of the Himalayas ? What is the economie significance of this difference ?

5. What are the physical characteristics of the Indo-Gangetic plains ?

6. What is meant by 'ravine land ? Where do they occur most in Indi and why ?

7. How do the Payanghat plains differ from the Indo-Gangetic plains ? Does this difference in any way affect the agriculture of the two plains ?

8. Describe the main features of the Fastern Ghats and write who they affect the lines of communications ?

9. What are the physical characteristies of the West-Coast plains ? Account for them.

10. What are the characteristics of the Aravalli Hills ? How do they contrast with the Vindhyas ?

---

6. Trans Geog. So.,cm Bombay, XVIII. pp. LVI, LXIX, XXV, 1868. XL

CHAPTER 2

Geological History

The geological history of the peninsular and extra-peninsular areas has been radically different. Since the latter end of the Palaeozoic eras the former appears to have been an area of dry land; no sedimentary formations of marine origin have been found except near the present sea coasts, and there they thin out against the older rocks on which they rest, in a manner suggesting that the shore line cannot have been very far removed from the present position of the coast when they were being deposited. In the extra-peninsular area, on the other hand, marine deposits range through the Palaeozoic and Mesozoic eras, and only in the latter part of the tertiary period is there any great development of deposit formed on dry land.

Structuraly these two areas differ greatly. The Peninsula has undergone no great compression since the close of the Palaeozoic era, and the beds all lie at low angles of dip. In the extra-peninsular area the conditions are totally different; the rocks have everywhere undergone great compression and disturbance since the commencement of the tertiary period, a disturbance which ranges in degree from the comparatively regular, though high dipping folds of the Baluchistan and Punjab hills, to the complicated overfolds and thrust faults of the Himalayas.

The difference in geological history finds its expression in the difference of the present contours of the two areas. In the extra-peninsular area we have mountain ranges which coincide with regions of special elevation, that is, the courses of the principal chains, and often of the minor ridges, are governed by their structure and are the direct result of the compression, and consequent disturbance and elevation they have undergone. As a result of this, the valleys are deep, narrow, and steep sided, the rivers and streams rapid and torrential in their nature, and as a rule, evidently actively at work in deepening their valleys. In the peninsular area, on the other hand, the mountains are all remnants of large table-lands, out of which the valleys and low lands have been carved. The valleys, with a few local exceptions, are broad and open, the gradients of the rivers low, and the whole surface of the country presents the gently undulating aspect characteristic of an ancient land surface.

Such, broadly speaking, and subject to some minor exceptions, are the contrasting characteristics of the two areas. In the country lying west of the Aravallis, between them and the Indus, there is a tract of geographically debateable ground, which exhibits a combination of the characteristics of the two areas. The rocks exposed are very largely secondary and tertiary beds of marine origin, agreeing in this with those of the extra-peninsular area, while in their low undulating dips and absence of any marked degree of disturbance, they approach the type of the peninsular area. On the north-east again beds, belonging to formations which are characteristically peninsular, are found in the Himalayas of Sikkim and north of the Assam valley and in the hills intervening between the Brahmaputra and Barak rivers. We will find the explanation of these exceptions to the geological contrast between the two areas in the great structural disturbances which took place during the tertiary period, and profoundly modified the outlines of that ancient land surface of which the peninsula proper is but a remnant.

The most important mountain ranges of the Peninsula are the Western Ghats or Sahyadri, running along the western coast from the Tapti river to Cape Comorin, at the Southern extremity of the peninsula; the Satpura, running east and west on the south side of the Narmada valley, and dividing it from the drainage areas of the Tapti to the westward, and the Godavari to the eastward; and the Aravalli, striking nearly south-west to north-east, in Rajasthan. The so called Vindhyan range, north of the Narmada, and he eastern continuation of the same north of the Sone Valley known as the Kaimur range are merely the southern scarps of the Vindhyan plateau comprising Indore, Bhopal, Bundelkhand, *etc.* The pla'eau of Hazaribagh and Chhota Nagpur in Orissa appear to form a continuation to the eastward of the Satpura range, but there is no real connection between these elevations and the Satpura chain. They are formed of different rocks and there is no similarity in the geological history of the two areas, so far as it is known.

A range of mountains is along the eastern coast of the Peninsula and called the Eastern Ghats. This chain has not the same unity of structure or oil line as the Western Ghats. It is composed to the Southward of the South-eastern scarp of the south Mysore plateau, on the east of the Yellakonda range along the eastern margin of the Cudapah basin and further north of the south eastern scarp of the Bastar-Jaipur plateau, north-west of Vizagapatnam, and of several short isolated ridges of metamorphic rocks, separated from each other by broad plains and having in reality but little connection with each other. There are also several minor ranges, such as the Rajmahal hills in Bihar. the In dhyadri between the Tapti and Godavari, the Nallamalai near Cudapah, north west of Madras and the little metamorphic plateau, such as the Shevaroy, Pachamalai *etc.*, scattered over the low country of the Carnatic, South west of Madras.

The peculiarity of all the main dividing ranges of India is that they are merely plateau, or portions of plateau which have escaped denudation. There is not throughout the length and breadth of the peninsula with the possible exception of the Aravalli, a single great range of mountains that coincide with a definite axis of elevation not one with the exception quoted, is along an anticlinal or synclinal ridge. Peninsular India is, in fact a table land worn away by sub-aerial denudation, perhaps to a minor extent on its margins by the sea; and the mountain chains are merely the dividing lines, left undenuded between different drainage areas. The Sahyadri range, the most important of all, consists to the northward of horizontal or nearly horizontal strata of basalt and similar rocks cut into a steep scarp on the western side by denudation and similarly eroded, though less abruptly, to the eastward. The highest summits such as Mahabaleshwar (1371 metres) are perfectly flat-topped and are clearly undenuded remnants of a great elevated plain. South of about 16 North latitude, the horizontal igneous rocks disappear, the range is composed of ancient metamorphic strata and here there is in some places a distinct connection between the strike of the foliation and the direction of the hills but still the connection is only local and the dividing range consists either of the western scarp of the Mysore plateau or of isolated hill groups, apparently owing their form to denudation. Where the rocks are so ancient as are those that form all the southern portion of the Sahyadri, it is almost impossible to say how far the original direction of the range is due to axes of disturbance; but the fact that all the principal elevations such as the Nilgiri, Palni *etc.*, some peaks of which rise to over 8000 feet or 2438 metres, are plateau, and not ridges tends to show that denudation has played the principal part in determining their height.

The southern portion of the Sahyadri range is entirely separated from the remainder by a broad gap through which the railway from Madras to Beypur passes west of Coimbatore. The Annamalai Palni and Travancore hills, south of this gap, and the Shevaroy and many other hills groups scattered over the Carnatic, may be remnants of table land once united to the Mysore plateau, but separated from it and from each other by ancient marine denudation. Except the peculiar form of the hills, there is but little in favour of this view, but on the other hand there is nothing to indicate that the hill groups of the Carnatic and Kerala are areas of special elevation.

The whole of the western Satpura from their western termination in the Rajpipla hills to Asirgarh consist of basaltic traps, like the Sahyadri. It is true the bedding is not horizontal, but the dips are low and irregular, and have no marked connection with the direction of the range. The central Satpuras, comprising the Pachmarhi or Mahadeva hills from the gap in the range at Asirgarh to near Narsinghpur are composed chiefly of horizontal, or nearly horizontal

traps, but partly of sandstones and of metamorphic rocks and there is here again, as in the southern Sahyadri, some connection between the strike of the foliation in the latter and the direction of the ranges. The highest peaks however—those of Pachmarhi (1319 metres)—are of horizontal Mesozoic sandstones. Farther east still the Satpuras consist entirely of horizontal traps terminating in the plateau of Amarkantak, east of Mandla. East of this plateau there is, north of Bilaspur, a broad expanse of undulating ground at a lower level, and farther to the eastward again rises the metamorphic plateau of Chhota Nagpur, capped in places by masses of horizontal trap and laterite. These formations were apparently once continuous, across the low ground near Bilaspur with the same strata on an equal elevation at Amarkantak. Similar outliers occur on the Bundelkhand plateau, north of the Narmada, all tending to the same conclusion—that the low valleys of Central Indian Republic are merely denudation hollows, cut by rain and rivers out of the original plateau of the peninsula.

It is true that some small ridges are formed of Azoic and Mesozoic sandstones, in places where the beds of these systems have been disturbed, but the only important lines of disturbance in either appear to be due to older axes of metamorphic foliation, and it is a rare case to find that the strike of the sandstones appears to have had much effect upon the directions of the hills and valleys.

The Aravalli differs from the other great ranges of India in being entirely composed of disturbed rocks, with the axes of disturbance corresponding with the direction of the chain. The formations found in the Aravalli range belong to the Cuddapah rocks, and are of great antiquity; for the most part they are much altered, they are quite unfossilised, and there is evidence which renders it probable that the elevation of the range dates from a period anterior to the desposition of of the Vindhyan rocks, themselves of unknown age but almost certainly not of later date than Keweenawan (Algonkian), whilst the fact that these Vindhyan rocks are found almost horizontal in the neighbourhood of the Aravalli range, on both sides of the chain, shows that here, as elsewhere in the Peninsula, the forces which have affected the extra-peninsular area in later geological epochs have not been felt.

The Archaean System

The geological history of India reveals rocks of different characters and different geological ages, ranging right from Archaean era to recent times. The oldest of these, often described as the Bundelkhand gneiss from its having been first recognised in the country of that name, is characterised by its massive structure, and extreme rarity of accessory minerals. This type of gneiss is also met with in the peninsula at several localities, and is recognised there under various names—(1) Balaghat gneiss, also named Bellary gneiss, (2) Hosur gneiss (3) Arcot

gneiss, (4) Cuddapa gneiss *etc.* The oldest basement gneiss of some parts of Rajputana belongs to this system. The gneiss of Bundelkhand is also remarkable for being traversed by extensive trappean intrusions, none of which penetrate any of the younger formations.

The second important type of gneiss is called Bengal gneiss. The Bengal gneiss is revealed in the gneisses of Bihar, Manbhum and Rewah, and some other parts of peninsula also. The Bengal gneiss is closely associated with Schists of various composition.

The third type of gneiss is Nilgiri gneiss or generally called Charnockite Gneiss. These rocks are of wide prevalence in the Madras state, and constitute its chief hill-masses-the Nilgiris, Palnis, Shevaroys *etc.*

In the extra-peninsula, gneiss and crystalline rocks are again exposed along the whole length of the Himalayas, forming the bulk of the high ranges and the backbone of the mountain system. This crystalline axis runs as a broad central zone from the western most Kashmir ranges to the eastern extremity in Burma.

The Dharwar System

The Dharwar Systems are the most ancient metamorphosed sedimentary rock-systems of India, as old as, and in some cases older than, the basement gneisses and schists. D. N. Wadia goes on to say that "the weathering of the pristine Archaean gneiss and Schists yielded the earliest sediments which were deposited on the bed of the sea, and formed the oldest sedimentary Strata, known in the geology of India as the Dharwar System".

The rocks of the Dharwar System are hornblendic and chloritic Schists, phyllites and conglomerates, associated with contemporaneous trap, banded jasper, and haematitic quartzites.

The Dharwar System is very well developed in Mysore, Andhra Pradesh, Madras, Madhya Pradesh and in Aravalli region *etc.*

In the Himalayan region, due to greater folding and inversions of strata, the rocks of Dharwarian system are not clearly visible. Whatever rocks of Dharwarian system occupy in the Himalaya, they are mainly seen in the form of states, phyllites, Schists, quartzites, crystalline limestone and dolomites *etc.*

The Dharwars have attracted a special interest on account of the valuable minerals they include : iron ores in great richness and purity in the Madhya Pradesh and Mysore, Copper ores disseminated at a particular horizon in Singbhum, and gold in the quartz reefs of Kolar are examples well known.

Cuddapah System

Upon the weathered surfaces of the highly folded Dharwars and the associated gneiss and Schists of the Archaean group, enormous

thickness of sediments were deposited in peninsular India. These rocks being devoid of fossils, isolated occurrences cannot with certainty be correlated, and consequently local names have been freely used to distinguish them. In Southern India we have the Cuddapah System, amounting to 6100 metres in thickness with several unconformities, covered, also unconformably, by a thin series of strata distinguished as the Kurnool System. Examples of rocks of this system occur near Kaladgi, in north Maharashtra country in the valley of the Bhima, near Pakhal in the Godavari valley, in the valley of the Penganga in parts of the Mahanadi valley, and in the valleys of Cheyair and Krishna and Papaghni. Some areas of Cuddapah rocks occur in Chhota Nagpur Jeypor and Bastar, South Singhbhum which must originally have extended as one large area probably continuous with the occurrence in the Chhatisgarh area of Madhya Pradesh. Farther west, in Madhya Pradesh, are series of old rocks distinguished as the Gwalior and Bijawar series, and finally there is the great Vindhyan System, all being unfossiliferous, except in lower portions.

In each of the groups of the Cuddapah series sandstones or quartzites prevail at the base and earthy deposits forming shales or slates above, limestones often occurring with the latter.

The equivalents of the Cuddapahs and Delhi in the Himalayan areas are the Dogra, Attock and Simla Seates and some parts of Haimanta etc.

The Vindhyan System

The Cuddapah were succeeded by the rocks of the Vindhyan system after time interval marked by earth movements and erosion.

The Vindhyan system has been divided very unequally into a lower and an upper division—and the lower division includes large quantities of material that appears to have been ejected from volcanoes, producing beds of siliceous material which, when very fine-grained, have a characteristically porcelainous aspect, and when in coarser fragments resemble some of the old greywackes.

The upper Vindhyan system is remarkable for including rocks in which diamonds are found. The most important product of the system, is however, its resources in lime and building stone.

They occupy a large extent of the country—from Sasaram and Rohtas in western Bihar to Chitorgarh on the Aravallis, with the exception of a central tract in Bundelkhand; while a large area of Vindhyan rocks is covered by the Deccan trap.

In the lower strata of Vindhyan system some marine deposits are also found and in its upper part shallow-water deposits are found, which represent a semi-arid climate. These shallow-water deposits

contain sandstones and shales. Along with the shales gypsum is also found intermingled. In Kumaon the Vindhyan system is known as Ralam series and this series overlie the Martoli series. This Ralam series extends in between the rivers Gori and Lissar, in Pithoragarh district. This series of Kumaon contain the basalt, conglomerates, quartzites and dolomites. "They pass upwards into grey, purple and golden massive quartzites 500 to 800 metres thick, overlain by orange coloured massive dolomite 50 to 100 metres thick".

The Palaeozoic Group : *Cambrian to Carboniferous*

The Palaeozoic era shows the growth of vegetation and other organic materials. The remnants of these early immigrants are found in a fossiliferous shape in the older rocks. The living organism of this era were devoid of the backbone and the main organisms were mammals and reptiles. In the first phase of this era, the only form of vegetation was in the form of grass which later on grew into grass or ferns. The rocks of this age are represented by shale slates, sandstones and limestones. The marine fossiliferous rocks of Cambrian era are found in the northern region of India.

Marine fossiliferous rocks of Cambrian age are found at three places in the Himalayas. The first locality is the Salt Range in the north west Punjab, the second is the Spiti and Kangra and the third is the Baramula district of Kashmir.

The oldest fossiliferous strata in India are found in the Salt Range of the Punjab. The undoubtedly Cambrian beds are found lying on a formation of peculiar marl with beds of rock-salt and gypsum, possible of tertiary age, similar to the salt deposits of the Kohat area which will be referred to in describing the tertiary system of India. The occurrence of such old beds, lying over masses of much younger materials is due possibly to the former having been thrust bodily over the salt marl formation during the process of earth folding. Fossiliferous Cambrian rocks are also developed on a large scale in the mountains of the Baramula district of Kashmir to the north of the Jhelum. The Cambrian succession is best seen in the Spiti valley and the neighbouring region. The Cambrian group of Spiti may be divided as follows—

Haimenta System

Upper — Grey and green micaceous quartzites, thin slates, shales and light grey dolomites.

Middle— Bright, red and black shales with some quartzites.

Lower — Dark slates and quartzites which probably include some pre-Cambrian.

The examples of Haimantas in Uttarakhand are furnished in the north-eastern parts of Pithoragarh district by a series, which is known as Garbyang series. Garbyang is situated in the valley of river Kali-

Heim and Gansser named it after a village of similar name. This Garbyang series extends from Nampa to Nanda Devi. Some volcanic rocks in eastern Himalaya may probably belong to this age.

The Ordovician, Silurian, Devonian and Lower and Middle Carboniferous Systems

In Spiti Ordovician, Silurian and Devonian strata also found in wider extends. In Spiti the Ordovician is represented by the hard grey dolomitic limestones *etc.* The Silurian fauna is in corals with American affinities. A group of hard, white, unfossiliferous quartzites conformably overlies the silurian rocks containing some fossils of early age and is overlaid by fossiliferous lower Carboniferous rocks.

The Sind and Lidar valleys of Kashmir contain well developed Ordovician and Silurian systems. Elsewhere in Kashmir, the Cambrian strata are overlain by the Muth quartzites of upper silurian to Devonian age, or by the Agglomeratic states or Punjab trap of Middle Carboniferous or later age.

In the northern region Kumaon, some rocks of Ordovician period are found around Garbyang series, which are known as Shiala series. These series contain shales, greenish coloured limestones and at some places, breccia of crinoidel fragments. In addition to this, rocks of Silurian period also occur here which mainly contain violet coloured Sandy shales. In the northern regions of Kumaon, quartzites and dolomites often occur of different depths, which are from the upper Silurian to the Devonian period. The Devonian limestones, too, are found at some places. In Garhwal some rocks contain the Palaeozoic strata, which have been named as Jaunsar series by A. M. Heron; these rocks are mainly unfossiliferous in nature. In the central Himalaya of Kumaon, especially between Almora and Rakshas Tal, Heim and Gansser have recognised the following rock formations.

Muth Series	—Brown quartzites with dolomite layers, capped by white quartzites. A special feature of this is the crinodal limestone of Lipu-Lakh—Silurian to Devonian.
Variegated Series	—Repetition of marls and shales of red, green, grey colours with layers of limestone—Silurian.
Shiala Series	—Calcareous sandstones and thin layers of lenticular limestone with crinoid fragments—Ordovician.
Garbyan Series	—Slaty phyllites, calcareous sandstones, Sandy and argillaceous dolomites—Cambrian.

Ralam Series	—Basal Conglomerates, greywackes, orange coloured dolomites—Lower Cambrian and possibly partly Precambrian.
Martoli Series	—Phyllites, Calcareous phylites, quartzites : Probably equivalent to the Algonkian.

The Gondwana System

There occurred a great change in the stratigraphical history of India after the deposition and uplift of Vindhyan rocks. At that time, *i.e.*, at the end of Palaeozoic era, *i.e.*, towards upper Carboniferous, there occurred some changes, which was also responsible for the mountain building movements called the Hercynian or variscan.

At that time there existed a massive southern continent, known as Gondwana land. In Gondwana times India, Africa, Australia, and possibly South America, had a closer connexion than they appear to have at present. Although probably at no time forming a continuous stretch of dry land, they were sufficiently connected to permit of the free commingling of plants and land animals. At different parts of this great Southern continent there occur peculiar boulder-beds whose special characters appear to be best explained as the result of ice action. The most important fact regarding the Gondwana system is its mode of origin—

"Although in a general way the Gondwanas were deposited in faulted depressions which have a general correspondence to the present disposition of their outcrops, it should not be supposed that in every case these outcrops imply the original fault bound basin. Some of the boundary faults may be of post Gondawana age. The original limits of deposition of the individual beds now found in these basins may not correspond in every case to the present outcrops. The strike of these faults delimiting the Gondwana basins is E. W. in the Bengal-Bihar area and NW=SE in the Mahanadi and Godavari valleys., The downtrough of main hunting faults are generally unequal in amount, *e. g.*, on the south side of Damodar valley basins the throw is much greater than on the north margin, the basins on the Godavari and Mahanadi have subsided much more on their N.E. margins than on the S.W. It is this circumstance that has determined the prevailing dip of Gondwana strata to the south in the former area and to the N.E. in latter. Minor cross or oblique faults are also seen in the basins, these have afforded channels for the later igneous intrusions".

The three large tracts in the peninsula can be marked out as prominent Gondwana areas—

(1) A linear tract in Bengal in the valley of the Damodar river and a considerable area of Rajmahal Hills.

(2) An extensive area of Madhya Pradesh to the south-east in Mahanadi valleys.

(3) A series of more or less connected troughs forming on elongated band along the Godavari river from near Nagpur to the head of its delta.

The composition of Gondwana rock series consists to a large extent and also to comparatively greater depth of red and yellow coarse Sandstones, Shales, Conglomerates, pebbly grits *etc*. The Gondwana formation has been divided in many series *viz*., Talchir, Damuda, Panchet, Mahadeva, Rajmahal, Jabalpur.

The Talchir series of Gondwana formation resemble greatly with the Mandhali beds of northern India. The red sandstone is the main rock of these formations, but some limestone and ordinary sandstones are also found mixed with the former. The fauna and flora of this age were mainly the water dwellers.

During Carboniferous period the climate of the world was comparatively wet and warmer, which resulted in the formation of dense forests. Vast swamps were covered by a most luxuriant growth of vegetation. There were thousands of species of plants, varying from minute algae to giant ferns and huge trees. In this swampy environment coal was being formed. As the plant life breathed in the Carbondioxide from the air and assimilated the carbon, the first step in coal making occurred. Practically all Indian coal seems to be deposited in certain linear tracts.

Most of the Coal in the Gondwanas is found in the Damuda or Damodar System, *i.e.*, both in the Barakar and Raniganj Series, the former being the more important one.

Upper Carboniferous and Permian Systems

In the Spiti area, the Conglomerate layers of Carboniferous period lie over the Silurian beds which belong either to upper Carboniferous period or to the Permian age.

The unfossiliferous Jaunsar series are found extending from Simla to Nayar river in Garhwal. The Simla slates have been underlain at some places by Blaini series. The post-Blaini rocks, which exist there, are known as Infra-Krol, Krol or Tal series, which can probably be of either Permian or Jurassic ages. According to Dr. Stoliczka these infra-Krol and Krol series belong to the Carboniferous period, which greatly resemble the Damuda series of Southern India. The Krol limestones are of marine and dolomitic in nature, whereas in the Tal series the current bedded quartzites and molluscan remains are most frequent.

The carboniferous strata in Kumaon are not easily recognizable due to excessive erosion and denudation. The Permian rocks overlie the Muth quartzites. These rocks of Permian period are known as Kuling Shales. The depth of Kuling Shales in Kumaon ranges from

30 to 50 metres. In the northern region of Kumaon, rocks of Tethys Himalayas and Mesozoic period are found, which are intermingled with the intrusive and extrusive basaltic rocks. The sedimentary rock mass of Tethys Himalayas, here, generally composed of limestones are called the "Exotic blocks". According to Heim and Gansser, the Exotic blocks contain pink, red and white limestones ranging from Permian to Cretaceous periods.

In Garhwal the lowest Krol-bed bears a slaty colour, the middle Krol has purple shales and the upper Krol contains the massive limestones. The best development of Krol is seen in the outer Himalayan region from Subath to Naini Tal.

In the Lesser Himalayas of Darjeeling, Buxa Duars, Bhutan and some other places, the upper Carboniferous and Permian are represented by the Gondwanas in which typical Barakar rocks with Carbonaceous shales and poor coal seams have been recognised.

Mesozoic Group : *The Triassic System*

The Marine Triassic bed in Himalaya extends from Kashmir to Sinkiang. The best example of the development of Trias is furnished in Painkhanda. The three lower beds of Trias contain "Otoceras-ophiceras fauna, in addition to this, species like "Episaegeceras' dalailamae Hungarites, Meckoceras hodgsoni *etc.*, are also found in the Trias bed.

The Spiriferina beds overlie the limestone beds of Niti. At Gomsali, quartze, mica-Schierts, *etc.*, are found.

The ptychites or Muschelkalk beds which are found in this region species contain such as Hollondites Voiti, H. ravana, ceratites thuilleri *etc.*

The Ladinic stage which is 6 meters thick contain few fossils, The other stages are Noric stage and Carnic stage. The Noric stage can be divided into lower, middle and upper.

According to Wadia, the Triassic series have well been developed in the northern region of Kumaon and like the Spiti series the Trias in Kumaon and Garhwal are not calcarious. Heim and Gansser have divided the Trias of North and north east Kumaon into the following geological series :—

1. Chocolate Series
2. Kalapani limestone
3. Kuti Shales
4. Kiota Limestone

In Salt Range the Triassic system is confined to the Lower Trias and the lower part of the Middle Trias, while in Baluchistan and Burma it is confined to the upper Triassic Stages only.

The Jurassic System

In the geosynclinal zone of the Northern Himalayas, Jurassic Strata conformably overlie the Triassic in a great thickness of limestone and Shales. Rocks belonging to the Jurassic system are developed it the Indian region in the Himalayas of Spiti, Kumaon, Nepal, Kashmir Hajara, Salt Range, in Cutch and Rajasthan.

Jurassic rocks, known as Spiti Shales, are developed in the Spiti region.

The Laptal series of Jurassic system extends from Kungri—Bingri to Laptal in North west Kumaon. The thickness of this series near Leptal is from 6 to 80 metres, where it is found in many layers. At the top of the Laptal series, a layer of Shaly ferruginous oflite is found, which has an average thickness of 3 to 4 metres.

In the Jurassic period limestone and shales were deposited in the geosynclinal zone of northern Himalayan region.

In the Johar region of Kumaon the place of Triassic rocks is taken by Liassic limestones which include the nodular and grey, brick-red and black limestones. In the Lesser Himalayan region of Garhwal, east of Ganga river, in the midst of outer tertiary zone and inner crystalline zone, where highly metamorphosed old sediments are found, the fossiferous Jurassic beds are also found as exceptions, which underlie the Eocene Nummulitic limestone beds and above it the Krol-beds are found, which are succeeded by the Tal series, in the upper portion of it shalow quartzites and limestones are found.

Jurassic rocks are also found in a small area north of the Banihal pass in the Pir Panjal mountains. Jurassic rocks are also found in Jaisalmer (Rajasthan).

Jurassic rocks occupy a large area in Kutch. The Jurassic sequence has been divided into four main divisions which are named Patcham, Chari, Katrol and Umia series from below to upwards, and range in age from Bathonian to Neocomian.

The Cretaceous System

Not only in the history of Himalaya, but in the geological history of India also, divergent factes of sedimentary system belonging to cretaceous period are found. The region, where the mighty Himalaya stands today, had been occupied by the Tethys geosynclinal facets. Proofs of igneous actions of great magnitude are found, and roks belonging to cretaceous age are found in the Himalayan region. These rocks comprise both plutonic and volcanic phases. In immense quality of magma was intruded in the pre-existing strata of Himalayas.

According to V on Krafft proofs of volcanic phenomena are found in the Cretaceous rocks of Kumaon, such as the existence of Cretaceous

rocks overlying the Spiti Shales, the best example of whose distribution is found in Johar region. Yellow-coloured siliceous sandstones and quartzites are found in some portions of the northern Himalayan ranges belonging to Jurassic era, which have been named as Guimal Sand Stone.

In the Spiti, the Giumal sandstones of lower cretaceous age and the upper flysch sediments of upper Cretaceous age are generally found. In the basal portions of these sandstones, lie the layers of shales with calcareous includes, which includes the glacuconite. The Hriumil Sandstones are overlain by grey or whitish limestones, which is called as Chikkim limestone. The Chikkim limestones are well developed in Niti pass. The upper part of Cretaceous has been named as upper flysch by Heim and Gansser, which has been assumed as 1000 metres in thickness.

The Cretaceous limestone is found in abundance in the exotic blocks area of Johar. The grey limestone of the lower Jurassic period is found here, which is succeeded by white limestone, intermingled with the igneous rocks. Next to it comes the Permian—Jurassic limestone. This has been called by Heim and Gansser as Chitichum facies. It is likely that volcanic activity should have been associated with the exotic and chitichum facies. It has been proved by Von Krafft that the exotic blocks of Cretaceous period have found with igneous rocks.

Cretaceous rocks are also well developed in Kutch and Narmada valley. The cretaceous rocks of Southern India are classified into three stages :—

(*i*) *Ariyalur stage*. The rocks are grey to light brown argillaceous sandstone and white sandstone.

(*ii*) *Uttattur Stage*. The group derives its name from a large ochreous matter, prevail throughout the group, and the southern portion of the area constitute almost the entire bulk of the deposit.

(*iii*) The Trichinopoly is conformably overlain by the Ariyalur stage. The Cretaceous system is well represented in parts of South Arcot, Pondichery, Godavari District and Assam.

The Deccan Traps

The close of the Mesozoic era was marked by the outpouring of enormous lava flows which spread over vast areas of western, central and Southern India. The most extensive and best known eruptive activity is the Deccan trap. The great lava-flows which make by far the chief part of this formation constitute the plateau of the Deccan, concealing all older rocks over an area of 2 0,000 square miles, rolling up the old river valleys, and levelling the surface of the country. Subsequent denudation has carved these lava-flows into terraces and flat-

topped hills, with, as in the rearward face of the Sahyadri or western Ghat range, steep scarps, rising to about 1219 metres and indicating a part only of the original thickness of the accumulated lavas, ashes, and beds of inter stratified marl. The trap-rock is usually a form of oliven basalt or angite-andesite, rarely porphyritic, but often vesicular with amygdala of beautiful zeolites, calcite and agate.

At the base of the flows are beds in which limestones of Lacustrine origin predominate. These beds, known as the Lameta series, were laid down unconformably on all the older formations, even on the youngest members of the Gondwana System, while they were themselves exposed to local denudation before the lavas spread over and protected them from the weather.

The Tertiary Group

At the end of Cretaceous age, the land reptiles and the water ammonites perished. Afterwards the fauna and flora grew up due to the suitability of physiographic and environmental changes of whatever nature. Amongst the animals, the mammals remained the chief species and in the Mesozoic period, the pteridosperms and cycads were the main plant species, which gradually lost their existence in the tertiary period and flowering plants grew up in their place, which are the dominant plant groups of tertiary period.

The Rise of the Himalayas

There are no two opinions of the geologists regarding the fact that the mighty Himalayas rose during the early tertiary period. During the course of the rising of Himalayas, five strange earth movements occurred. The first movement of that sort took place in the Middle upper Cretaceous periods. When the Tethys was furrowed into a series of ridges and basins running longitudinally, the Radiolarian charts began assembling into its deeper parts and in the shallow portion of it the flysch sediments were deposited.

The second upheaval took place in the upper Eocene period, followed by a third in the Middle Miocene. At the end of the Pliocene period, *i.e.*, at the end of Siwalik sedimentation, the fourth upheaval occurred followed by the fifth and last one in Pleistocene times. At that time the Pir Panjal of the Lesser Himalayan ranges reached its present height. Dutoit, a famous geologist, recognised only three upheavals.

Whatever be the phases of the gradual evolution of Himalayas, that will be dealt somewhere else, but it should be mentioned here that the quartzitic sandstones of Tertiary period interrelated with seams of red clay. Clays are generally purplish brown, mottled with grey and are harder than the Nahan clays.

Eocene to Miocene Systems

Marine conditions prevailed in Lower Tertiary times along the foot of the Himalayas, as far east at any rate as Garhwal, and the deposits of marine Sabathu beds can be traced at intervals north-westward to Jammu, while Nummulitic rocks occur also in the Salt Range; over various parts of the Punjab, covering up large tracts of older rocks, at the back of the zones of crystalline, and now generally snow-covered, peaks in the far parts of Kashmir and Ladakh; on the Tibetan border in Spiti and Kumaon; and away to the far east in the region of Tibet north of Sikkim. Still farther east, in Assam and Burma, Nummulitic rocks occur in numerous places.

In Sind, where the tertiary marine rocks have attained an exceptional development, the following subdivisions are recognized :—

Manchhar	Miocene to Pliocene
Gaj	Miocene
Nari	Oligocene to Priabonian
Kirthar	Lutetian
	Ypresion
Ranikot	Sparnacian

Representative of Eocene rocks, which are so well developed in Sind and Baluchistan, occur also in Salt Range, Potwar, Kashmir and Burma on the one hand and Kutch, Gujarat, Rajahmundry and Pondichery area on the other.

In Sind there is a fine display of marine miocene beds in the Kirthar range, where the series is out through by the Gaj river and is named the Gaj series in consequence. In Simla Himalaya beds of corresponding age are well developed on the Ratnagiri coast, South of Bombay, beds of Gaj age are exposed overlain by laterite.

Middle Miocene to Lower Pleistocene

The rocks of this age have received different names in the different areas. They form the Siwalik system along the outer Himalayas; the Manchhar system in Sind; the Dihing series in Assam and the Irrawady system in Burma.

The name Siwalik, now applied, to the fringing foothills of the Himalayas in the Punjab and Uttar Pradesh, is also used to indicate a great system of river deposits remarkable for its wealth of vertebrate

fossil remains. The deposits of sand, clay, and conglomerates are essentially similar to those formed in modern times by the Himalayan rivers; and their relations to the modern alluvium show that they were produced in the same way, and were then caught up in the folding moments by which the Himalayas, rolling out as a mighty rock-wave towards the South, rose as the greatest mountain range in the world.

The Siwaliks are divided into three major divisions, *viz.*

Upper Siwalik
Middle Siwalik
Lower Siwalik

In the Siwaliks and Lesser Himalayas at least three "thrust zones" have been assumed, and the southernmost thrust zone has been called as the main Boundary fault, which separates the Siwaliks from the Earlier Tertiary and older rocks. According to Pilgrim, Auden *etc.*, the main Boundary fault in Kumaon, separates the Middle and Upper from the lower tertiary. The tertiary rocks are separated by the Krol thrust of the Pre-Tertiary autochthonous belt. The same structural units are found in the South and S.E. of Simla and Garhwal. Here the Siwalik region is separated from the Simla states by the main boundary fault, which is covered by Nummulitic and lower Tertiary strata. The zone had been thrust upon the Krol-nappe where rocks of different geological ages are found.

According to Heim and Gansser there are at least four Superimposed thrust sheets in the central Himalayan region which stretch upon the Nummulitic rocks. The Synclinal of Nainital too, is an extension of the Krol belt.

The most interesting and, for stratigraphical purposes, the most important among the fossil remains found in the Siwaliks are those of vertebrate animals, especially of the mammalian class.

Very pertinent evidence as to the age of the upper Siwaliks is obtained in Burma, where the basin of the Irrawaddy contains a great system of beds, chiefly composed of yellow sands, which attain in some places a thickness of 61 metres are rest, with slight unconformity, on marine beds.

The Tipam sandstones of Assam are of the same age as the Siwaliks and the Irrawaddy series have been found in Burma. In the island of Piram to the east of Kathiawar, in the gulf of Cambay, there are Middle Siwalik rocks which have yielded some mammalian fossils.

Pleistocene and Recent

In the Kashmir valley there are vast deposits of boulders, sand and clay, in which occur remains of mammals regarded by Mr. Middlemiss

as of Pleistocene age. They are known as Karewa. These have been described from time to time by various observers of Lacustrine origin, but from a detailed study of them, Mr. Oldham concluded that their mode of origin was similar to that of the alluvial deposits in process of formation in the same valley at the present day.

The laterite may be of early Pleistocene age. The Narmada and Tapti rivers flow in a large basin covered by extensive Pleistocene and Recent deposits. Recently, among the older alluvium of the higher part of the Godavari valley, remains of extinct vertebrates have been found, including a skull of Elephas namadicus. These, like the vertebrate remains found many years ago in the Krishna valley, indicate a Pleistocene age.

The imost important and extensive among the deposits of very young age in India are the great alluvial accumulations on the confluent plains of the Sutlej, Ganga and Brahmaputra.

The older alluvium of Peleistocene and the newer alluviums of recent times are found in the northern Plain of India. The alluvial deposits of India can be classified under two subdivisions—old and new deposits. The older deposits are commonly known as Bangar while the newer ones are called Khadar. The Bangar land occupies the higher ground and everywhere contains carbonate of lime, usually occurring in nodules called Kankar, used largely as a source of lime and as road metal. The Khadar contains neither Kankar nor reh salts.

The newer alluvium occurs only near the present flow of the rivers. These rivers bring the eroded material in abundance and in this region due to their lessened velocity, leave the alluvium only on their banks.

QUESTIONS

1. Describe fully the geographical distribution of the Dharwar System of rocks in India. Give a concise account of the minerals of economi c importnc associated with them. (*Agra, M. A.*, 1954).

2. Discuss the influence of the Tertiary earth-movements on the structure and Topography of India. (*Agra*, 1955.).

3. Describe fully the most important physical changes that took place in India during Tertiary era. (*Agra*, 1956. *Allahabad*, 1960).

4. Describe the geological history of Peninsular India and account for the main features of its present relief. (*Agra*, 1957.).

5. Discuss fully either the origin of the Northern plain of India or the relief and drainage of Peninsular India. (*Allahabad*, 1959.)

CHAPTER 3

Climate

Climate occupies the fundamental position in the study of Economic Geography. On the one hand, it determines, to a large extent, the production of commodities, and on the other, it controls and creates markets for them by determining the wants of men. In no other country is the production of commodities, so dependent upon climate as in India. Millions of poor farmers gaze at the sky during the summer months in the hope of seeing the clouds that bring them rains which start agricultural operations of the year. Even in these days of economic progress, untold misery is the lot of the Indian farmer if, perchance, the rains fail; or some other climate phenomena destroy his, crops. Climate affects not only the agriculture, but all other aspects of India's life. Our clothing, our houses, our roads and railways, our food and our very health and capacity to work depend upon climate.

India's climate is governed by :—

(a) Her relation to the big land mass of Asia; and (b) her relation to the Indian Ocean. The Monsoon type of climate, under which Indian climate falls, is directly the outcome of the extraordinary pressure conditions that develop in Central Asia during the winter and summer months. The word 'Monsoon', derived from the Arabic word *MAUSIM*, meaning season, implies seasonal change of prevailing winds. During winter, the prevailing winds are off-shore from land, during summer, these winds become onshore from sea. This change from the land winds to sea winds and *vice versa* is the cause of all the characteristics of a monsoon climate.

To understand Indian climate, therefore, it is necessary for us to study the pressure conditions of Central and South-Eastern Asia, which bring about this change of winds.

In the following map is given the distribution of air pressure for January in Asia. It will be noticed that at this time an anticyclone with high pressure covers the land mass of Asia. The centre of this anticyclone is in Siberia near lake Baikal. The average pressure for Irkutsk at this time in 77^{0} mm. A secondary centre of this anticyclone has established itself in the Punjab: the pressure at Peshawar being 765 mm.

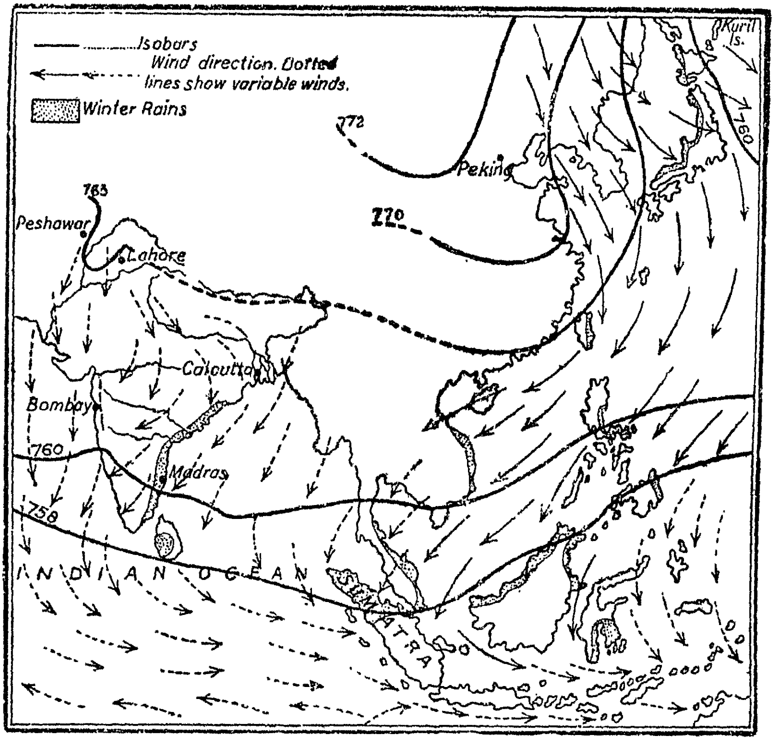


Fig. 8. Pressure and winds for January.

As opposed to this, low pressure occurs in the North Pacific near the Kurile Isles and in the equatorial regions to the south. Further south in Australia also there is low pressure, as it is summer there. As the wind blows from the high pressure to the low pressure region, this pressure distribution naturally places the whole of the eastern and southern Asia under the regime of land winds which are called 'Winter Monsoon'. These are usually dry, off-shore winds which merge, over part of the area, with the N. E. Trade Winds. The Winter Monsoon may also be called the Dry Monsoon. As appears on the map the winds blow more steadily in eastern and south-eastern Asia than in the Indian region where they are weak and irregular.

Now, look at the map (Fig. 9) giving the pressure distribution for June. The increasing amount of heat received from the sun and the consequent heating of the big land mass of Asia has changed the entire position. The high pressure area now lies on the Pacific, south of Japan. There is another high pressure area on the Indian Ocean and in Australia where it is winter now. The continent of Asia, intensely heated, is

almost entirely a low pressure area, with three centres of marked low pressure; one of which is in Pakistan near Multan where the pressure, about 747 mm. is the lowest of all the three centres. The prevailing winds, therefore, become onshore, blowing from the sea to the land.

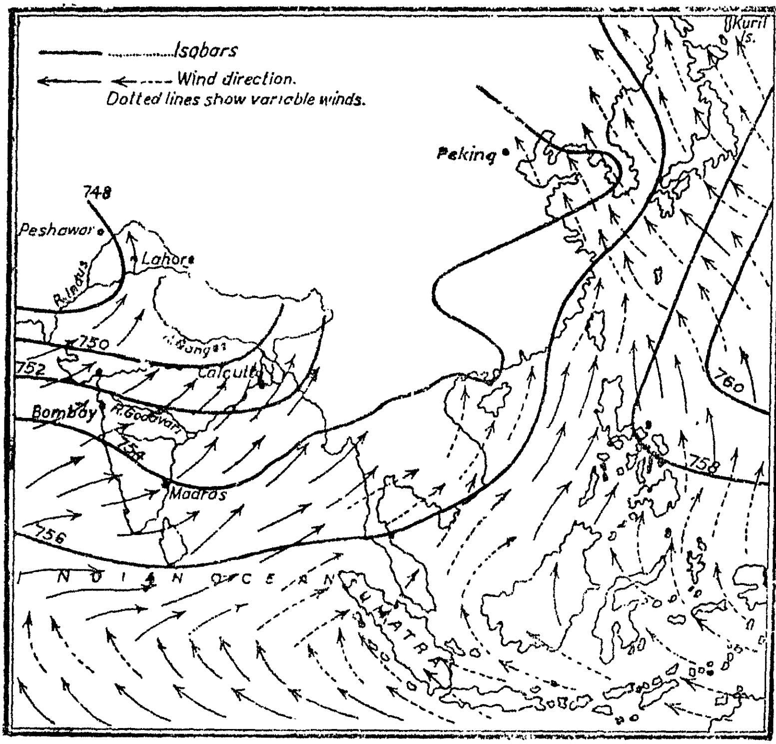


Fig. 9. Pressure and winds for June.

In the beginning, while the summer-temperatures are yet rising, these sea winds are drawn only from over short distances of the sea. But gradually as the low pressure area over Pakistan intensifies even the S. E. Trade winds blowing in the southern hemisphere join the general movement of air towards this low-pressure. During May the pressure in Pakistan is about 750 mm.; during June it becomes 748 mm. but during July it becomes as low as 746 mm. near Multan. This causes onrush of the monsoon. These winds come to us almost suddenly, as South-West or Summer Monsoon'.

Gradually as the sun starts back on its southern journey, the temperature in India becomes lower and the old pressure conditions re-

establish themselves. The South-West Monsoon, therefore, weakens and we have once again the Winter or Dry Monsoons. The period of transition from Summer to Winter Monsoons lasts from September to December, after which the Winter Monsoons are in full control until about May. Thus from June to December, India is under the influence

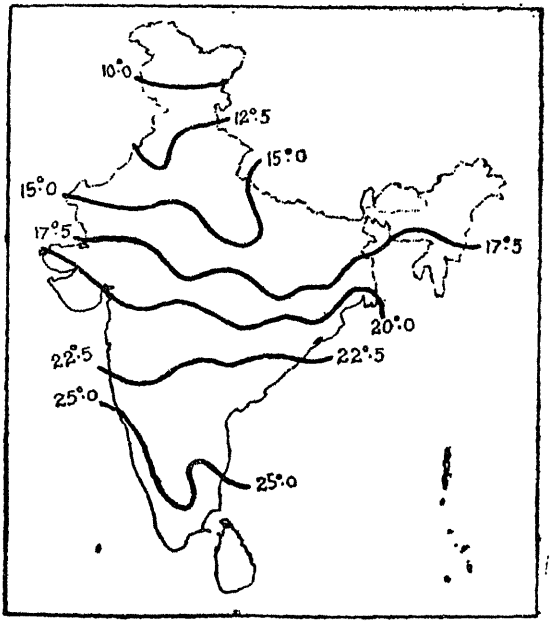


Fig. 1c. Mean temperature in January (in centigrade).

of the South-West Monsoons coming from thousands of kilometres of warm ocean. From January to May, it is under the influence of the off-shore Dry Monsoons coming from land. The oceanic and land character respectively of these monsoons determine the salient features of Indian climate.

WEATHER IN THE DRY MONSOONS

Considering generally, the weather in India during the period of Winter or Dry Monsoon is marked by "clear skies, fine weather, low humidity and temperature, light northerly winds and a large diurnal variation of temperature".[1] There is, however, a great difference between this generalised statement and the day-to-day realities. The anticyclone, mentioned above covering North-West India weakens from time to time. This is characterised by the inraid of a number of cyclones

1. Normand, *The Weather of India.*

which introduce an element of change in the weather condition of northern India during winter. About nine-tenths of these cyclones come here from the Mediterranean *via* Iran; while the rest are born in Central India or in the Arabian Sea. Their path generally lies along the Himalayas. The country south of 21° N. is not visited by them generally. These are similar in type to the European cyclones, though not so intense. Most of these depressions give a small amount of rain to the whole of Northern India, and heavy snowfall in the higher Himalayas. The passage of these cyclones is accompanied by marked changes in temperature. Their approach is marked by a rise in temperature and

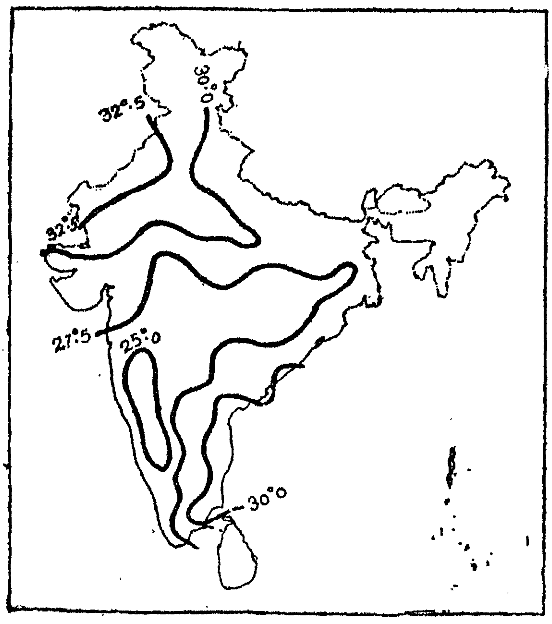


Fig. 11. Mean temperature in July (in centigrade).

their end is marked by a fall in temperature. It is then that the weather becomes frosty.[2] The amount of snowfall from these cyclones in the mountains depends upon the moisture in the air drawn into them. When more of the air from the Arabian Sea is drawn into them the snowfall in the hills is considerable. This is possible only when the path followed by them is more southerly. The path followed by these cyclones is determined by the equatorial doldrums. When the position of the doldrums is more to the north, the path of the cyclones in India

2. Temperatures fall occasionally from about 8° to 11°C. below normal, and several degrees of frost have occurred on rare occasions in the plains of north-west India.

is more to the north. There is, therefore, less of the air from the Arabian Sea drawn into them. But when the position of the doldrums is more to the south, the path followed by the cyclones is more to the south. This allows more moisture-bearing air to be drawn into the cyclones, and heavy snowfall in the mountains is the result.

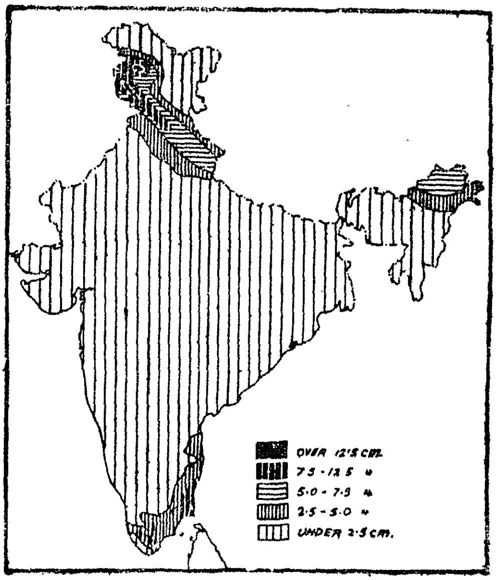


Fig. 12. Distribution of Winter rainfall in India.

Heavy snowfall in the hills causes a very cold weather to follow the cyclones. Owing to the circular motion of air around the low pressure in the cyclone, the cold air of the snow-covered mountains is brought to the plains of India where a cold wave results. The frequency of these western depressions is on an average, 2 in November 4 to 5 per month during December to April and about 2 in May.[3]

The first period of the Dry Monsoon is characterised by low temperatures, which are lower in the north-west, where the anticyclone lies, than in the south which is nearer the equator.[4] The temperature during this period throughout the Indo-Gangetic Basin is considerably lower than in the peninsular India. The following table (IV) shows this :—

3. M. S. Randhawa, *Agriculture and Animal Husbandry in India*, p. 35.

4. The mean maximum ranges from about 28.8°C in parts of the Peninsula to 18.3°C in the north-west, while the mean minimum decreases from about 23.8°C in the extreme south to below 4.4°C in the north-west.

TABLE IV : *Winter and Summer Temperature*

(in degrees Centigrade)

	Winter (Jan.)		Summer (May or June)	
	Max.	Min.	Max.	Min.
Peshawar ..	17.2	5.0	40.5 (June)	25.0
Lahore ..	20.6	4.4	41.1 (June)	26.1
Delhi ..	21.1	8.8	40.0	26.6
Allahabad ..	23.3	8.8	41.6	26.6
Nagpur ..	28.3	12.7	37.7	27.7
Madras ..	28.8	19.5	36.6	27.2
Calcutta ..	26.6	12.7	36.1 (April)	23.8

The second period, which may be said to begin from March is marked by an appreciable rise in temperature and decrease of barometric pressure in India due to the northward march of the sun. Fig. 11 shows that the month of July records the highest temperatures over greater part of India. During the hot weather months—March to May—local sea winds prevail in the coastal districts and dry land winds in interior. Hence, temperature is highest in the interior and there is a large contrast of temperatures between the interior and the coastal districts. With the steady northward movement of the area of greatest heat in India, the equatorial winter bulk of low pressure also moves northward. The isotherms are closed curves with a central area of highest temperature. In March the highest day temperature occurs in Deccan—about 38°C. in April the highest temperatures, 38°C. to 43°C. occur in the tract lying from Rajasthan and the Punjab to Chhota Nagpur, Orissa and Sircars. The maximum temperature in May is over 40.5°C. over most of the North-West and Central India. In the north-west desert, day temperatures of 49°C. or over are not infrequent. The mean minimum temperature exceeds 21°C. over the whole country in May and is over 26.6°C. in the eastern half of the Peninsula. These temperatures increase from the south to the north and north-west. Thus, both the highest and the lowest temperatures in India, are recorded during the period of this dry, off-shore monsoon. The country cannot get the benefit of sea during the regime of this monsoon.

During this period important changes take place in the surface air movements over India. The northerly winds of the winter monsoon get modified and air circulation over India and the adjacent seas becomes a local circulation characterised by increasing land and sea winds in the coastal regions. In northern India the winds are strong westerly during day and weak with variable direction during night.

Violent local storms often form in regions where deep humid winds from the sea meet the hot dry land winds. These storms are often accompanied by violent winds, hail and torrential rains, and are on that account very destructive. In West Bengal and Assam they are known as 'Norwesters' on account of the accompanying squall being usually from the north-west. Sometimes the showers are heavy and prolonged—this is chiefly the case in the damp regions and eastern Bengal and Assam. Hail storms are comparatively more common in the Punjab, the west U.P. and in Assam and its neighbourhood. They also occur in the central parts of the country and the ocean.

About the close of the period of this dry monsoon, the days in the Upper Ganga basin are characterised by the blowing of the dry scorching westerly winds, locally known as 'Loo'. These winds are drawn owing to the unusual heating of the plains during the day. They stop blowing during the night. The afternoon and late evenings are sometimes marked during this period by hurricanes, which also are due to local heating. Sometimes they move at terrific speed seventy or eighty miles an hour, and cause considerable damage.

But while the 'loo' blows in the north, in the extreme south the proximity of the sea allows oceanic winds to penetrate to some distance into the land and give light showers, as soon as the summer temperatures have risen considerably. These rains are not, however, part of the monsoon rain. They are only light, as the winds drawn are only from a short distance of the sea and are not, therefore, so highly saturated as the south-west monsoon. The south-west monsoon sets in only much later when the low pressure at the equator south of India has disappeared, thus allowing the South-East Trade Winds to be drawn across the equator as South-West Monsoons.

During the winter the general flow of surface air over the country is from north to south, north-westerly in the plains northerly in the central parts and north-easterly in the south of the peninsula and the neighbouring seas. The winds blow with little speed because of the anticyclonic conditions that prevail over most of the country. In this season the air is mainly of continental origin and hence of low humidity. From about the middle of December, the serenity of the weather in north India is broken at intervals by a series of disturbances which travels eastwards across Persia, northern India and China. On an average four to six disturbances may be expected in each of the months of January and February. The precipitation associated with them is small in amount but very important for winter crops of north-west India.

Taking the season as a whole, temperature is lower in the north-

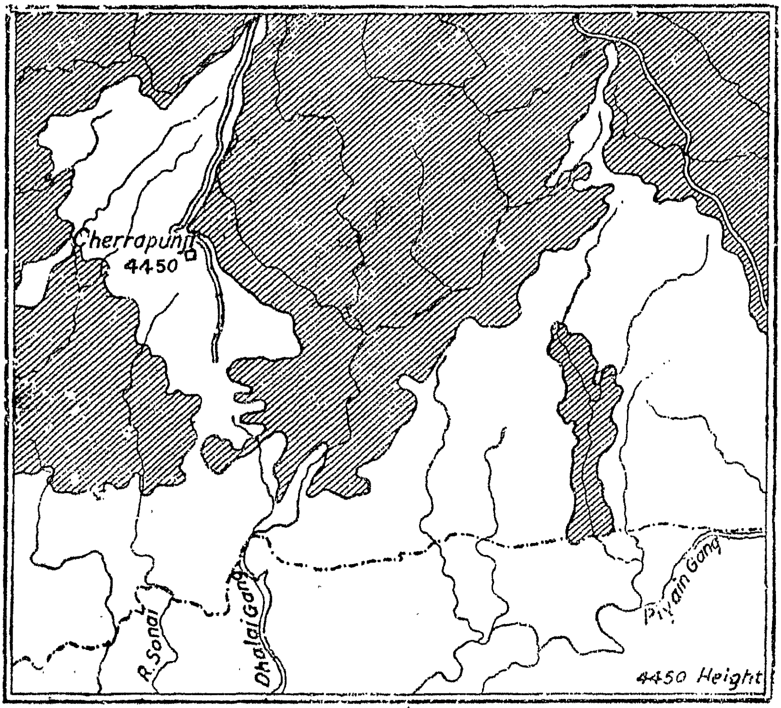


Fig. 13. Position of Cherrapunji (Hills are shaded).

west and increases eastwards and southwards. Rainfall is greatest in north-west and decreases eastwards and south-wards generally.

Weather in the wet Monsoon

The Summer or Wet Monsoon is divided into two branches : (i) the Arabian Sea branch and (ii) the Bay of Bengal branch; owing to the peculiar shape of the Indian Peninsula. The Bay of Bengal branch strikes land much later, but gives rain to the greater part of the country. The Arabian Sea branch, though more powerful, usually spends itself up in ascending the Western Ghats which deprive it of most of its moisture. Certain currents of the Arabian Sea branch reach the interior of the Peninsula through the Narbada gap and join the Bay of Bengal current in Chhota Nagpur. The Palghat gap similarly allows this monsoon to reach into the interior of the peninsula.

The Summer or West Monsoon is also called the South-West Monsoon, because it blows originally from the south-west. Its direction over India is, however, modified by the general position of the low pressure area in the north-west; to which it is naturally attracted;

and the direction of mountains, especially the Arakan hills and the Himalayas. The result is that in U.P. the so-called South-West Monsoon actually comes from the East

With the advent of the South-West Monsoon there is an appreciable fall in temperature. The high humidity of air, however, makes the moist heat unbearable. The conditions, in fact, in every way resemble those in the equatorial regions.

The chief importance of the South-West Monsoon lies in its rainfall. This Monsoon has been blowing for thousands of miles over a warm ocean capable of much evaporation. It is, therefore, highly saturated when it strikes land. The Bay of Bengal branch strikes the

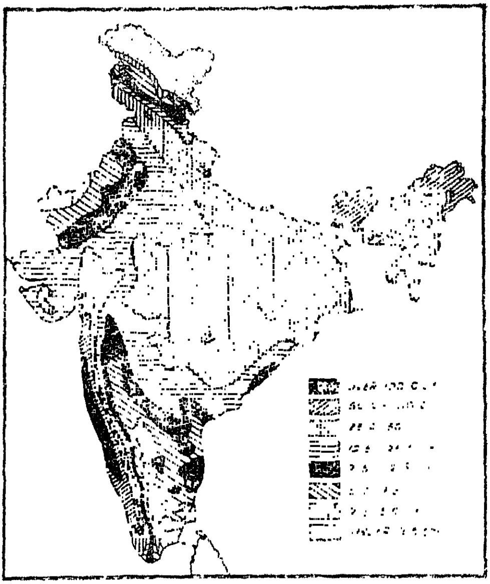


Fig. 14. India—Mean Annual rainfall.

Arakan Coast and thence passes on into funnel-shaped formation of the Garo and Khasi hills, shown in Fig. 13. The ascent of these moisture-laden air currents in this funnel gives Cherrapunji an average annual rainfall of 1080 cms. which, if allowed to collect, will submerge completely a modern four-storeyed house. After emerging from this funnel, the Monsoon air loses much of its buoyancy and moisture, so that Shillong, which is only about twenty-five miles away from Cherrapunji, gets only about 215 cms. of rainfall annually. The Monsoon currents now follow their path along the Himalayas giving rain

until they reach the Punjab where they meet another section of the Arabian Sea Branch. The rainfall decreases as these currents move into the interior, as the supply of moisture in them decreases gradually. The rainfall is greater near the Himalayas, and near the coast in Bengal, than it is in the interior or away from the Himalayas.[5]

Distribution of rainfall in India depends largely on its orographical features. It has been remarked, if the hills and mountains of India were effaced, the country will receive much less rainfall.'[6] Part of the rainfall from the Monsoon in India is *Orographical* and part *Cyclonic* or *Convectional.* All along the Himalayas and the Western Ghats the Monsoon currents try to ascend the mountain barrier which results in condensation of moisture and rainfall. In this orographical or relief type of rainfall the windward slopes of mountains get more rainfall than the leeward sides, which are in the rain shadow.

The cyclonic rainfall, on the other hand, is due to the passage of a number of depressions, or cyclones, some of which are of local origin due to local heating, while others take their rise on the neighbouring sea and move landward. These depressions intensify and concentrate rainfall in their vicinity. The rainfall is, therefore, sometimes more and sometimes less in a particular locality in India according to the intensity of the cyclone. Consequently, the Summer Monsoon does not give continuous rain in any part of India. Bursts of general rain alternate with breaks, partial or general. Intensification by these depressions often lead to floods. This pulsatory character of the Monsoon rainfall is one of the most important features, and is economically important for the proper growth of crops.

It is also due to these depressions that lands away from the mountains are able to get rainfall. For ordinarily the Monsoon winds try to cross the Himalayas and concentrate their rainfall there only. It is only through the depressions that the moisture-bearing monsoon passes over the plains and gives rain there.

5. The following figures show this tendency :—

Darjeeling gets 126.4′ (321 cms.) of rainfall; Shillong 84.6′ (215 cms.); Simla 61.0″ (155 cms); Dehradun 85.0″ (216 cms.); which coastal stations of Bombay, Madras and Calcutta get 71.2″ (181 cms), 49.9″ (127 cms), and 62.9″ (160 cms.) respectively.

There is a marked decrease in rainfall from east to west *i.e.* while Calcutta gets 62.9″ (160 cms.); Patna gets onlv 46.6″ (118 cms), Allahabad 41.8″ (106 cms.), Lucknow 40.0″ (101 cms.), Kanpur 35.9″ (91 cms.) and New Delhi gets 26.2″ (66 cms.).

(Source; *India*, 1962, pp. 10-12).

6. Normand, *The Weather of India.*

Convectional rainfall also takes place sometimes due to local heating which produces cumulous clouds in the afternoons. This type of rain is strictly local and occurs mostly in autumn or spring (*i.e.*, October and March). Heat produces a local convectional current in the air which rises up. The moisture in that rising current is condensed at some height and clouds form. These clouds on rising further begin to give rain. The convectional rains in India are generally very light, as this phenomenon occurs in India, at a time when the temperatures are not ordinarily very high. The local heating, therefore, cannot produce very strong convectional currents in the air which could rise very high and thus give much rain.

Usually the strength of the Monsoon currents and the accompanying rainfall increase from June to July and remain steady till about the end of August. The currents then begin to weaken and do not reach far into the interior; that is to say, the Monsoon begins to retreat. This retreat of the Monsoon is due to the retreat of the sun towards the southern hemisphere. The retreat begins first in those parts where the advent of the Monsoon was the latest, that is to say, from places far into the interior. The following table (V) shows the approximate dates when the S. W. Monsoon starts and ends in certain States in India :—

TABLE V : *Monsoon Time Table*

State	Commencement	End	Duration days
Bombay	5th June	15th October	132
Bengal	15th June	15th-30th October	132-137
U. P.	25th June	30th September	97
Punjab	1st July	14th-21st September	75-82

The Arabian Sea monsoon current retreats southwards from Rajasthan, Gujarat and the Deccan by a series of intermittent actions. The Bay of Bengal current similarly retreats down the Ganga plain. The low pressure conditions previously prevailing in North India disappear by October, and are transferred to the Bay of Bengal by the beginning of November. This retreat of the Monsoon is followed by dry weather in Northern India and general rainfall on the coastal districts of Madras and Orissa States where October and November are often the rainiest months of the year.

The retreat of the S. W. Monsoon is associated with a number of storms which affect only the coast, especially along the Bay of Bengal. On an average 1 or 2 severe cyclones may be expected in the pre-monsoon period, and 2 or 3 in the post-monsoon period. These storms

(Tornadoes and Typhoons) cause sometimes very high tidal waves which do considerable damage in the low-lying areas near the coast. The tidal wave accompanying the Bakarganj storm of 1876 was one of the most destructive on record. About one lakh people were drowned in about half an hour on the alluvial flats of the River Meghna. About two decades ago a cyclone of this type passed over Bengal, details of which were given in a communique as follows :—

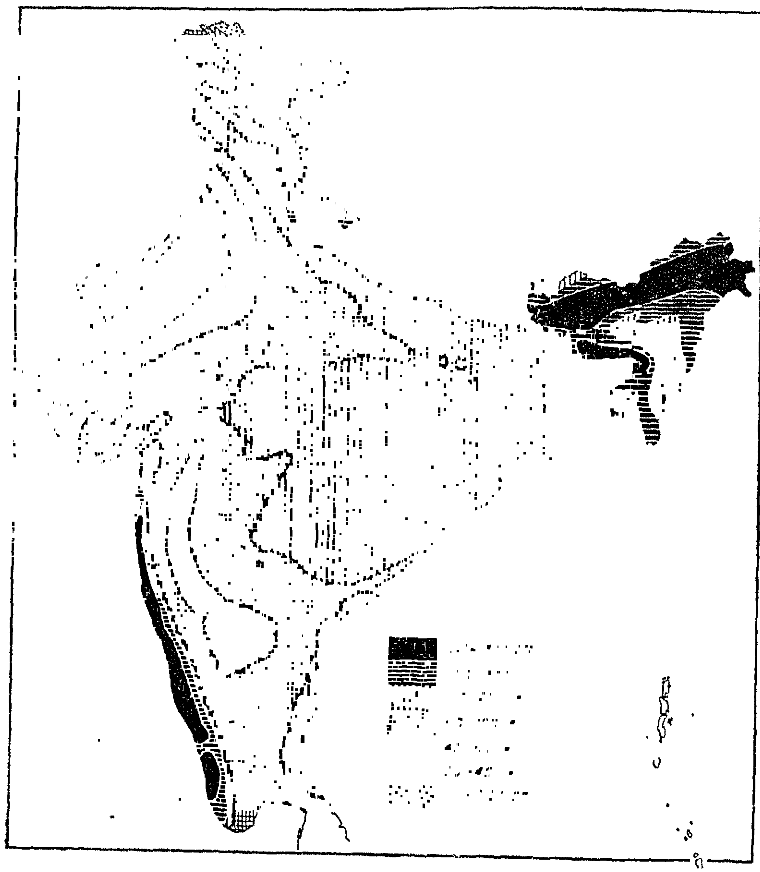


Fig. 15. India—Mean Annual Rainfall (in centimeters)

"A heavy cyclone from the Bay passed over several districts of Bengal on October 16, 1942. It began at about 7 or 8 o'clock in the morning on October 15 and spent itself up in the early hours of the morning of October 17. In the afternoon of the 16th there was a high tidal fore forced up by the cyclone from the Bay which broke into the mainland and devastated a considerable area in the southern part of Midnapore and 24-Parganas. The cyclone was accompanied by

heavy rain. At certain places it was as heavy as 12 inches in less than 24 hours. All the rivers in these districts were in heavy flood, due to the tidal bore, rain and the force of the wind. In the worst-affected areas, there was a heavy loss of human lives—the present estimate being not less than 10,000 persons in the Midnapore district and 1000 persons in the 24-Parganas district. The loss of cattle was even heavier, nearly 75 per cent. As to houses, practically every kutcha house was severely damaged or destroyed."

Distribution of Temperature

The Tropic of Cancer divides India roughly into two equal parts; the Warm Temperate and Tropical. But on account of the monsoon character of Indian climate, very little effect is produced by the Tropic of Cancer on the distribution of temperature in India. The extreme south is the only part of India where latitude may be said to have a preponderating influence on temperature distribution. But there, too, the peninsular character of land lets in oceanic influences which considerably modify temperatures.

In Northern India, or the part north of the Tropic of Cancer, the temperatures during the winter months are controlled, apart from the slanting rays of the sun in winter, by the anticyclone that covers this area then. The temperatures vary between 13°C and 18°C. A slight change occurs in these temperatures whenever cyclones disturb the anticyclone. For a few days, marking the approach of the cyclone, the temperatures are slightly higher. For a day or two, signifying the end of the cyclone, the temperatures are slightly lower. It must, however, be remembered that it is during the closing days of the cyclone that the lowest winter temperatures are recorded locally.

In Southern India, or the part south of the Tropic of Cancer, the temperatures during the winter months are controlled by the proximity to the Equator and the oceanic influences. The temperatures generally increase from about 18°C near the Tropic of Cancer to about 26.6°C at the southern extremity. There are, however, local variations, due to elevation above sea level or proximity to the sea. Fig. 10, giving the isotherms for January, shows (by the southerly bend of isotherms) that winter temperatures are warmer on the east coast than on the west coast. This is largely due to the higher elevations on the west. This effect of elevation is also brought out clearly by the isotherm of 23.8°C enclosing the plateau of Mysore.

The summer temperatures in Northern India are largely the effect of :—

(i) Direct rays of the sun, owing to the sun being overhead in the northern hemisphere.

(ii) Continentality, emphasising land influences far from the sea.

(iii) Anticyclone, which maintains steadily rising temperatures.

(iv) Modification by the breaking of the South-West Monsoon which brings rain.

As the sun crosses the Equator for the north, temperatures in India begin to rise. But Fig. 11, giving isotherms for May, shows that there is little difference in the summer temperature between Northern India and Southern India. The isotherm of 32.2°C covers the greater part of India, more or less surrounding it. In the neighbourhood of the sea, the isotherms tend to follow the direction of the coast. This is due to the penetration of the oceanic influence.

During June when the sun shines overhead at the Tropic of Cancer, the highest temperatures are not found in that region. The highest temperatures are found in areas that have not yet received the monsoon rains. Thus, the hottest temperatures in India during June and July are in the south-west of the Punjab, Central India and Rajasthan. In all areas where the south-west monsoon has penetrated, the temperatures have come down considerably.

The distribution of day-to-day temperatures over the different parts of India is, however, entirely different from the above generalised, seasonal distribution of temperatures. The temperature may rise above 38°C, in a place in West Pakistan on day during summer, and may fall to 4.4°C or thereabouts during the night. Both the highest and the lowest temperatures have been recorded in Jacobabad in Sind (Pakistan). On individual days in May, maximum temperatures exceeding 48.8°C have been recorded in West Rajasthan, the highest temperature recorded being 50°C at Shri Ganganagar.

There is a considerable range between winter and summer temperatures in India, except in Malabar. Malabar may be considered, to enjoy the Equatorial type of temperature regime, in which the difference between winter and summer temperatures is very little. The range of temperature increases as one proceeds into the interior of the country from south to north. While in Malabar the range between the hottest and the coldest month is about 33°C and in south-eastern Madras about 6.6°C, in south-western Punjab it is more than 22°C.

The range of temperature is much greater in the interior of the country and especially in the north-west India than on the coast and in the neighbourhood of the seas; and as a general rule is greatest in the driest spring months and least in the rainy season. On the mean of the year the diurnal range is 14°C to 16.5°C in the north-west India and decreases towards the east and south. The range is 8.25°C to 11°C in the north-east India and the coastal districts from Saurashtra to Lower Burma. Throughout the dry tract to the west of the Jamuna

and the Aravallis, the daily range of temperature is greatest in October and November when the diurnal range is not less than 16.5°C and rises to 22°C in places. In the north-west of the Peninsula and adjoining areas the greatest range of 16.5°C to 19°C occurs in February and March.

An important feature of the distribution of temperature is the sudden change from winter to summer, and summer to winter. The period of spring and autumn is, therefore, limited in India. This feature is more marked in the north than in the south. The following table (VI) gives the temperatures of three different areas to illustrate the comparative steadiness of temperatures during the period of the South-West Monsoon, and the sudden rise and fall of temperature during spring and autumn respectively.

TABLE VI. *Mean Monthly Temperatures in degrees C.*

Areas	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	D.c.
Punjab S.-W.	12.2	14.4	20.5	26.6	32.2	34.4	33.8	32.2	30.5	25.5	18.8	13.3
Bengal	18.3	20.5	23.3	28.3	28.8	28.8	28.3	28.3	28.3	26.6	22.7	18.
Madras S.-E.	24.4	26.1	28.3	30.0	31.1	30.5	29.4	28.8	28.3	25.0	26.1	24.4

In the above table, in the Punjab from February to May there is a rise of 17.8 C and a similar fall from September to December. But from June to September there is a change of only 4°C. In the other two cases also the same tendency is present.

This feature of temperature distribution has a great significance for crop production in India. The uniformly high temperatures during the period of the greatest rainfall are of great benefit for the quick growth and maturity of the Summer or *Kharif Crops*. The low stocks of food, which the Indian peasant usually has about this period of the year, are thus quickly replenished. The sudden change from summer to winter enables the cultivator to sow the Winter or *Rabi Crops* while the ground moisture received during the rainy season has not dried up, and is still available for the germination of the crops. The sudden change from winter to summer, however, proves disadvantageous for the best maturity of crops.

Rainfall Distribution

In the following table (VII) are given the monthly rainfall figures for India. It will be clear from these data that India gets more of her

rain (about 90%) from the South-West Monsoon, and secondly, that 78% of the rains are received in the months of June, July, August and September, *i.e.*, 2/3 of the year remains dry :—

TABLE VII : *Monthly Rainfall in Cms.*

Month	Rainfall	Percentage	Remarks
January	3.941	1.0	
February	5.156	1.5	
March	5.820	1.8	In Assam eastern Himalayas and Western Ghats.
April	8.388	2.5	
May	19.277	5.6	
June	55.659	16·3	78.7% in these four months
July	89.130	26.2	
August	74.982	22.4	
September	47.244	13.8	
October	18.650	5.5	West Coast, Assam and Madras Coast
November	8.572	2.5	
December	3.331	0.9	

TABLE VIII : *Normal Seasonal Rainfall in India* [7]

Sub-Division	Full year (in cms.)
1. Assam ..	244.15
2. W. Bengal ..	187.82
3. Orissa ..	142.27
4. Chhota Nagpur ..	127.95
5. Bihar ..	120.52
6. East U. P. ..	97.82
7. West U. P. ..	93.95
8. Punjab E. & N. ..	58.12
9. Punjab S. W. ..	23.37
10. East Rajasthan ..	63.00
11. West Rajasthan ..	32.60
12. Kashmir ..	103.35
13. Central India (West) ..	84.07
14. Central India (East) ..	96.45
15. Gujarat ..	81.72
16. Konkan ..	273.32

7. M. S. Randhawa's *Agriculture and Animal Husbandry in India*, 1958, p, 33.

Sub-Division		Full year (in cms.)
17.	Deccan	77.17
18.	M. P. (West)	113.52
19.	M. P. (East)	130.10
20.	Malabar	259.35
21.	Mysore	90.02
22.	Madras (S. E.)	87.75
23.	Madras Deccan	61.30
24.	Madras Coast (N.)	100.40

The monsoon rains in India are often marked by the following four important variations from the normal :—

1. The beginning of the rains may be delayed considerably over the whole or a part of the country.

2. There may be prolonged breaks of rains lasting over the greater part of July or August when the summer crops needing plenty of moisture are just growing.

3. The rains may end considerably earlier than usual, causing damage to standing crops and making the sowing of winter crops difficult. Long breaks or an early abrupt termination of rains is disastrous to crops and produce droughts and famines.

4. The rains may persist more than usual in one part of the country and desist from another part. The last one constitutes the most common abnormality.

The summer rainfall in India comes in heavy downpours leading to a considerable run-off. This results in extensive soil-leaching and soil-erosion. London's 60 cm. of annual rain, for example, comes in 161 days in light drizzles leading to considerable sinking of rain water, while Bombay's 177.5 cm., comes in 75 days only, causing large proportion of the rain water to run off in torrents.

It will be realised that the alternation of a wet and a dry period is the fundamental feature of Indian climate. Owing to this alternation, the significance attaching to a rainfall distribution is naturally great in a hot country like India, whose life depends mostly upon agriculture. The map in Fig. 14 shows that over the greater part of the country **most of the rainfall comes during the period from June to October.** The months of November and December are important for rainfall only along the eastern coast of Madras and Orissa. During January

and February, however, there is a small amount of rainfall from winter depression in the Punjab and the Indo-Gangetic valley generally.[8]

Figs. 14 and 15 show that the two areas of *Heaviest Rainfall* in India are :—

(I) the western slopes of the Western Ghats mountains (including Konkan, Malabar and south Kanara),

(II) the southern slopes of the Assam hills (including Manipur and Tripura) and the eastern Himalayas. The rainfall here is more than 255 cm. annually.

The two areas of the *Scantiest Rainfall* are :—

(I) the Thar and Sind, and

(II) a small part of Orissa. The annual rainfall here is less than 25.5 cms.

Over the rest of the country the rainfall generally varies from 50 cms. to 200 cms. The areas near the coast and those near the Himalayas have more rainfall than areas away from these two locations. However, according to the observations of the Census Commissioner, 11 per cent. of the total area gets rainfall above 187.5 cms.; 21% between 37.5 cms. and 125 and 187 cms., 37% between 75 and 125 cms., 24% between 37.5 and 75 cms. and 70% below 37.5 cms.

The annual rainfall of India is 105 cms. *i.e.*, we get all over one lakh maunds of water on every acre of land. The variations from this normal is as great as +30 cms. and −20 cms. as occurred in 1917 and 1899 respectively.

The following map (16) shows that large areas in India and Pakistan are subject to a considerable variability of rainfall. The map shows that places with lower average rainfall have higher variability. Thus

---

8 The following table gives the annual distribution of rainfall according to different seasons:—

Rainfall Season		Duration		Precentage to the annual rainfall
South West monsoon	...	June-September	...	75.0
Post-monsoon	...	October-November	...	13.0
Winter or North-East monsoon		December-February	...	2.0
Pre-monsoon	...	March-May	...	10.0
		Total	...	100.0

(From *Agricultural Situation in India.*)

Naushera, in Sind, with a mean annual rainfall of 12.5 cms. has a variability of 53 per cent. But Kanpur whose annual average is 85 cms., has a variability of 20 per cent only. Calcutta, with its 162.5 cms. has only 11 per cent variability. The high variability in areas of low rainfall is, however, not such a serious menace to agriculture as the comparatively low variability in areas which have just enough rainfall for agricultural purposes. Any decrease in rainfall in such areas makes it impossible for agricultural operations to be carried on and a famine is the result.

The failures or variability of rain is not minded either by areas of heaviest rainfall or by areas of lowest rainfall. In areas of heaviest rain, there is always enough water available for the growing of some crops. In the dry areas, there is provision of a network of canals for irrigation that enable the crops to be grown. But other areas are hit severely. Such areas lie in the central part of the country, receiving from 75 cms. to 125 cms. of rainfall in normal years. This is the *Famine*

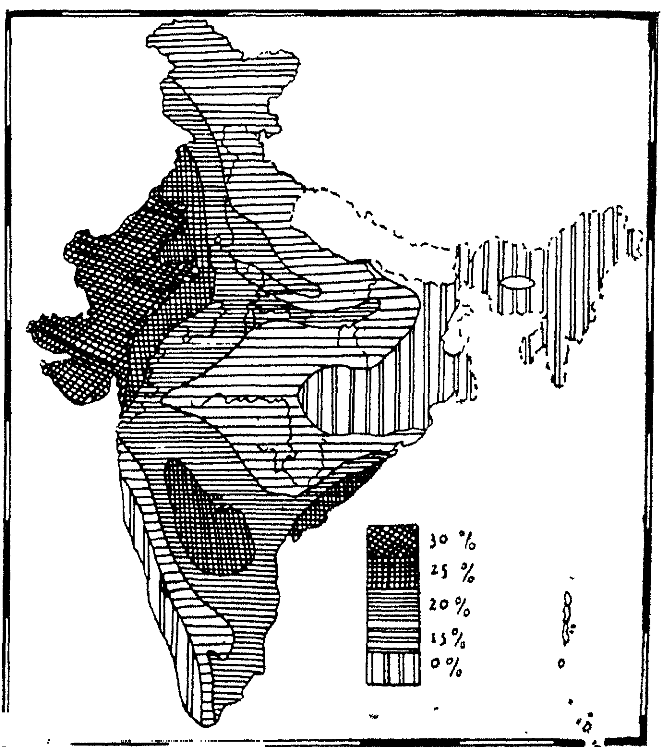


Fig. 16. Variability of rainfall in India.

Zone of India. In this area there is not enough rain for crops during normal years, so that adequate provision of irrigation facilities does not exist. This fact is the source of considerable suffering in times of drought.

In a very general way, it may be said that the climate of India is a Monsoon climate; having land winds blowing in winter and the early summer, and oceanic winds blowing in late summer. The late summer is, consequently, the *Rainy Season*. The rain-giving monsoon is known as the S.-W. Monsoon. It is divided into two branches, the Arabian Sea branch and the Bay of Bengal branch, because of the shape of the peninsula. The Bay of Bengal branch is forced into the interior of the country by the particular type of relief features. These features are the general direction of the mountains which almost confine the monsoon in India, and the river valleys like the Ganga Valley and the Mahanadi valley up to which the cyclones from the Bay of Bengal move. These cyclones are formed, because of the junction of the continental air of India and the oceanic air of the Bay of Bengal. They have a very great influence on the distribution of rainfall in India. The Arabian Sea branch of the S.-W. Monsoon practically exhausts itself against the Western Ghats. Its influence on the general distribution of rainfall in India is nominal.

The rainfall distribution in India is marked by a region of heavy rainfall along the windward slopes of mountains where the rainfall is more than 255 cms. It is also marked by a north-south running belt of moderate rainfall of 75 to 100 cms. per year occupying the central part of the country. To the east of this belt up to the mountains the rainfall is about 125 to 150 cms. To the west of the belt the rainfall is less than 75 cms., except along the Western Ghats. The deserts of Thar and Rajasthan have less than five cms. of rain. The importance of the winter cyclones for rain is also to be noted. Famines are an inborn character of Indian rainfall.

The temperature distribution in India is primarily the function of the latitude. The Tropic of Cancer passes through India. Low temperatures do not occur, as a rule, here except in winter in the Himalayas. There is also distinction between the temperatures of the Peninsular region and those of the Northern parts. In winter, the temperatures in Northern India are about 15.5 C. In the peninsular region, they are above 23.8°C. In summer, the temperatures in the north are very high in the early part, but they come down to about 32.2°C after the rains start. In the South the summer temperatures are about 32.2°C. The character of the night temperatures is a distinctive feature in the plateau region of the South. Even in summer, the nights are cool and breezy on the plateau.

Monsoon Forecasts

The strength of the summer monsoons in India depends on four factors. These are :—

(i) *The amount of snow that has accumulated in the Himalayas* by the end of May. If this amount is large, the monsoon tends to be weak, specially in the North-western part of the country.

(ii) *The air pressure in Mauritius* in the month of May, which typifies the air pressure over the Indian ocean. If this pressure is high, the monsoon is weak. For it tends to create anticyclonic conditions in India.

(iii) *The Rainfall in East Africa and in Zanzibar* during April and May which is an index of the air currents in the Equatorial doldrums. If this rainfall is high, the Indian monsoon is weak. For high rainfall in the doldrums can result only when the convectional currents of air are considerable. Such currents retard the flow of air from the Southern Indian Ocean into India.

(iv) *The air pressure in Chile* in South America during the months of March, April and May. If this pressure is high, the Indian monsoon is good. For it tends to create low pressure in the Indian Ocean and so the cyclonic conditions in India.

Effect on Economic life

India's climate has several important features that affect her economic life.

(i) The temperatures are never too low in winter in any part of India. This gives a long growing period, especially as the frost is practically unknown, except locally now and then. This feature enables India to grow temperate land crops during winter and tropical and sub-tropical crops during summer. In fact, but for the two driest months, May and June, the whole year is the growing season in India. In Bengal, Assam and the Peninsular region, wherever water is available for irrigation even in these dry months crops are grown in the fields. Thus, as many as three crops of rice can be grown in one year in these parts.

(ii) The largest amount of rain comes during the three summer months, June, July and August. This is utilised for the quick maturing of food crops like millets and maize, etc. The hot and moist climate of this period produces an abundant vegetative growth in the plants which is useful in providing plenty of fodder for cattle.

(iii) The summer temperatures are high and rise suddenly. The maturity of crops in India is, therefore, rapid. This rapid maturity of crops tends to deteriorate their quality. India is, therefore, not a

'quality' producer, but only a 'quantity' producer. This applies to winter crops as well as summer crops. For the harvesting period of both occurs during summer.

(iv) The concentration of rainfall to a few months in the year leaves the greater part of the year as dry. This does not encourage the growth of grasslands in India. Whatever grass grows during the rains is scorched during the dry season. Pasturage is, therefore, poor in India. Cattle and other stock have to be stall-fed.

(v) The geographical distribution of rain in India is such that areas of fertile alluvial soil (in the Punjab and U. P.) where the winter temperatures are cool enough for temperate land crops, get only a moderate amount of rain, about 75 cms. This enables them to grow a large amount of wheat.

(vi) The huge rainfall, coming immediately after the country has experienced great heat of summer, breeds many disease germs. Malaria, dysentery and a host of other diseases afflict the population during and after the rains. This saps the vitality of the people living in the wetter parts of the country and makes them inefficient and easy-going. The loss in efficiency due to diseases has not been less than 20 per cent. The fatigue and the ill-defined general conditions of debility produce a disinclination to hard work.

(vii) The hot and moist climate of the summer months not only tells on our health, but also tends to make us easy going. In contrast, the people in the temperate lands are forced to be active physically to keep them warm. This climatic drawback makes labour in India inefficient. This drawback, however, does not affect all parts of India to the same degree. The Punjabi, brought up in a dry climate, is entirely different from the Bengali living in a hot and moist climate.

(viii) The frequent failures of rain and the attendant misery and starvation facing millions engaged in agriculture have tended to make people superstitious. They easily lose heart and feel helpless against 'Fate'.

(ix) Climate exerts a great influence on agriculture. As the incomes of agriculturists fall (because of failure of rains, floods, etc.), their capacity to buy industrial goods and services is diminished. Lawyers, doctors and professional men find their incomes reduced. Failure of crops reduces railway earnings and affects the volume of exports. Rent cannot be collected and land revenue falls into arrears. It has, therefore, been rightly said that, "Budget" making in India is a gambling in rains.

QUESTIONS

1. What do you understand by Monsoon Climate and on what factors does it depend ?

2. Why is the study of the climate of India necessary for under standing its economic geography ?

3. Discuss the pressure conditions in South-eastern Asia in May. What is their effect on the weather conditions of India ?

4. What are the characteristics of Indian rainfall ? Discuss them in detail.

5. What is the significance of winter cyclones in Indian climate ?

6. Why is the distribution of rainfall all over India not uniform ?

7. It is said that the Indian Budget is a "Gamble in Monsoon." Do you agree with this statement ? Why ?

8. What causes affect the distribution of temperature in India during (a) the Winter and (b) the Summer ?

9. Describe the factors that enter into the forecasts of Indian Monsoons.

CHAPTER 4

Vegetation

There is a great variety in the natural vegetation of India. Considering the great variations in climate and physical features of the country, this is to be expected. Tropical, Sub-tropical, Temperate and Alpine; all classes of vegetation occur in this country.

Tropical Vegetation

Over the greater part of the country, however, it is the tropical vegetation that is found. Ordinarily, in other parts of the world, tropical vegetation is subdivided on a basis of moisture conditions into the following types :—

(a) Evergreen forest; (b) Deciduous forest; (c) Savannah; (d) Thorn forest; and (e) Steppe.

In India, however, according to Champion,[1] examples of well-defined tropical grasslands are lacking; though grassland is common enough as a secondary and a temporary phase of development under the influence of forest fire or grazing. The typical savannah type of other countries is also absent, as the closed deciduous forests here grade into thorn forest without any open grassy park-like stage.

Sub-Tropical Vegetation

The Sub-tropical, Temperate or Alpine vegetation is found in India only on the mountains. The sub-tropical conditions seem to be determined more by altitude than by latitude here and are characteristically developed in the hilly tracts. The sub-tropical Zone is really a transition from the tropical to the temperate Zone, and is sometimes difficult to be distinguished. Owing to a moderate summer monsoon rainfall, it seems quite well defined in the West and Central Himalayas as the Chir Pine Forest. In the north-west also where the rainfall is low and comes mostly in winter, there is a sub-tropical dry evergreen forest. Even in the Eastern Himalayas where there is a heavier summer rainfall, the sub-tropical belt of forest occurs between the tropical vegetation and the temperate oak forests. But on the hills of South India there

1. Champion, A preliminary Survey of the Forest Types of India and Burma, 1936.

seems to be no real break between the tropical and the temperate types; only a falling off in the luxuriance of forest being noticed. The small daily and seasonal range of temperature is evidently the cause of this there.

Temperate Vegetation

The temperate vegetation in India consists only of forests on mountains. There are no temperate grasslands in this country, as India does not extend into middle latitudes.

The Temperate forest in India are distinguishable in three classes. Two of them are mainly coniferous, while the third is predominantly broad-leaved. These classes depend mostly upon the rainfall during the season of vegetative activity, *i.e.*, the summer months with a mean temperature over 11 °C. The wettest type, which is the broad-leaf type, occurs both in the southern and the northern hills, but the moist and dry types, which are coniferous, occur only in the Himalayas.

Alpine Vegetation

The Alpine vegetation is found in India only in the Himalayas and the connected ranges. Above the timber limit, high forest is replaced by Alpine scrub, varying in form with the available moisture supply. The birch and the rhododendron are the commonest trees in the Alpine forests in the Himalayas. The forest is mainly evergreen, although several of the broad-leaved varieties are deciduous. These forests occur at altitudes of 2900 to 3500 meters.

Vegetation of the Plains

The natural soil covering of the plains in India is a closed forest. But very large areas in the plains are found to be almost, or quite, devoid of trees. They support only a meagre covering of grass. It is extremely probable that clearings for human habitation and agriculture are responsible partly for this. There is, however, another way in which closed forests can be destroyed and replaced by grass. Owing to the alluvial nature of the soil in the plains, the rivers continually swing backwards and forwards in their courses. It often happens that as a result of heavy rainfall in the hills, these rivers rise rapidly and carry down enormous quantities of clay and silt. Should it happen that the flood is of exceptional duration and volume, the rivers spread their waters over a large area. When this happens in evergreen forests, a deposit of clay and silt is laid down which ultimately leads to the decay of the forests. In the following year, in the evergreen forests, most of the tall trees and shrubs die out, owing to the clay deposit. The trees that are left soon disappear, owing to the attacks of fungi and insects. This phenomenon is quite common and is responsible for the destruction of the forest cover over large areas in the plains, close to the foot hills.

Overgrazing and forest fires lead also to the destruction of natural forests. The forest fires in India are most destructive during the cool weather when the grass is not wet and when the atmosphere is dry. During the summer months the grass underbush withers, while it is soaked during the rainy season and cannot, therefore, carry the fire.

Jhuming

The influence of man in the destruction of forests is most serious. Apart from the reckless cutting that is common to all parts of the world, Indian forests in Assam suffer from the practice of '*Jhuming*' which the backward tribes follow to clear the ground for cultivation. *Jhuming* is practised only between certain altitudes. There is no *Jhuming* above 2438 metres 8,000 ft. (2438 metres), for the reason that crops will not ripen so high. Below 1523 metres, the hill people do not go, for fear of heat and disease. The south-east, south, or south-west aspects are usually chosen in order to take advantage of the sun's rays, and all trees, even the largest are cut down in the cold weather. During the hot weather, the debris is set fire to at the lowest part of the Jhuming; the rising flames cause an upward draught and the fire rushes up the hill. When all is over, nothing is left but the charred and blackened trunks of the largest trees. As soon as the embers have cooled down, various seeds, such as rice, millet, pumpkins, etc., are dribbled into the earth with the ashes. The field is weeded once or twice during the rains before the crop is harvested. Next year and the following year the field is cultivated and then when the accumulated fertility of the soil has become exhausted, mainly through exposure and erosion, the area is abandoned. A distinctive shrubby vegetation then takes possession of the land, or it may be covered with a weed. In areas where there is a real land hunger, the "Jhumias" return at shorter intervals to the same field and the inevitable result is that the area does not get a chance covered with tree at all.

By and large, the forests of India may be classified into the following major types :—

(I) Moist Tropical forests

- (A) Tropical Wet Evergreen Type.
- (B) Tropical Semi-Evergreen Type.
- (C) Tropical Moist Deciduous Types.
- (D) Moist Seral Types—
  - (a) Tidal forests
  - (b) Fresh water Swamps

(II) Dry Tropical Forests

- (A) Tropical Dry Deciduous Types

(B) Tropical Thorn Types
(C) Dry Evergreen Type
(III) Alpine Forests
(IV) Montane Temperate Forests
(V) Montane Sub-Tropical Forests

I. Moist Tropical Forests

The Moist Tropical Forests are some of the most valuable forests of India. Broadly speaking the Moist Tropical Forests may be divided into the following main types—

(A) *Tropical Wet Evergreen Type.* These forests extend over a considerable portion of upper Assam region, in the Andaman Islands and along the Western Ghats, in the wet tracts where the rainfall is over 100 inches. The number of species in this forest is few; the most important tree being the *Dipterocarpus indicus.* A very interesting tree of these forests in the Assam region is *Aquilaria agallocha*, the diseased timber of which produces the renowned *aguru* wood of commerce, which is highly aromatic and is much prized as incense and for the extraction of a fragrant oil.

(B) *Tropical Semi-Evergreen Types.* A Second group of this major type is the Tropical Semi-Evergreen Forest which occurs in a strip in the west coast and Anadamans and on a fairly wide area in the Assam Bengal-Orissa region, with an annual rainfall of over 1500 mm. (60 inches). On the west coast, *Vateria indica*, *Hopea parviflora* and *Xylia Xylocarpa* are the important species wherever these forests have been allowed to survive; Xylia is characteristic of the forests on laterite soils.

(C) *Tropical Moist Deciduous Types.* A third group of this important type is the Tropical Moist Deciduous forests. They occur- in Orissa, Bihar (Singhbhum) West Bengal (Buxa) and Assam (Kamrup). In the Andamans the moist deciduous forests are noted for the *Padank* (Pterocarpus delbergioides), a very durable, hard and ornamental timber of great value.

(D) *Moist Seral Types.* May be divided into the following types—

(a) *Tidal Forests.* A very large formation is to be found in the great delta formed by the Ganga and Brahmaputra before joining the Bay of Bengal. The most characteristic trees belong to the mangrove family. Characteristic genera are *Heritiera*, *Bruguisa*, Rhizophora, Ceriops; in places the low palm occurs along the edges of creeks. Tidal forests occur to a small extent also in the deltas of the rivers on the east coast. Elsewhere in India, much of the tidal forests at the mouths

Overgrazing and forest fires lead also to the destruction of natural forests. The forest fires in India are most destructive during the cool weather when the grass is not wet and when the atmosphere is dry. During the summer months the grass underbush withers, while it is soaked during the rainy season and cannot, therefore, carry the fire.

Jhuming

The influence of man in the destruction of forests is most serious. Apart from the reckless cutting that is common to all parts of the world, Indian forests in Assam suffer from the practice of '*Jhuming*' which the backward tribes follow to clear the ground for cultivation. *Jhuming* is practised only between certain altitudes. There is no *Jhuming* above 2438 metres 8,000 ft. (2438 metres), for the reason that crops will not ripen so high. Below 1523 metres, the hill people do not go, for fear of heat and disease. The south-east, south, or south-west aspects are usually chosen in order to take advantage of the sun's rays, and all trees, even the largest are cut down in the cold weather. During the hot weather, the debris is set fire to at the lowest part of the Jhuming; the rising flames cause an upward draught and the fire rushes up the hill. When all is over, nothing is left but the charred and blackened trunks of the largest trees. As soon as the embers have cooled down, various seeds, such as rice, millet, pumpkins, etc., are dribbled into the earth with the ashes. The field is weeded once or twice during the rains before the crop is harvested. Next year and the following year the field is cultivated and then when the accumulated fertility of the soil has become exhausted, mainly through exposure and erosion, the area is abandoned. A distinctive shrubby vegetation then takes possession of the land, or it may be covered with a weed. In areas where there is a real land hunger, the "Jhumias" return at shorter intervals to the same field and the inevitable result is that the area does not get a chance covered with tree at all.

By and large, the forests of India may be classified into the following major types :—

(I) Moist Tropical forests

- (A) Tropical Wet Evergreen Type.
- (B) Tropical Semi-Evergreen Type.
- (C) Tropical Moist Deciduous Types.
- (D) Moist Seral Types—
  - (a) Tidal forests
  - (b) Fresh water Swamps

(II) Dry Tropical Forests

- (A) Tropical Dry Deciduous Types

(B) Tropical Thorn Types
(C) Dry Evergreen Type
(III) Alpine Forests
(IV) Montane Temperate Forests
(V) Montane Sub-Tropical Forests

I. Moist Tropical Forests

The Moist Tropical Forests are some of the most valuable forests of India. Broadly speaking the Moist Tropical Forests may be divided into the following main types—

(A) *Tropical Wet Evergreen Type.* These forests extend over a considerable portion of upper Assam region, in the Andaman Islands and along the Western Ghats, in the wet tracts where the rainfall is over 100 inches. The number of species in this forest is few; the most important tree being the *Dipterocarpus indicus.* A very interesting tree of these forests in the Assam region is *Aquilaria agallocha*, the diseased timber of which produces the renowned *aguru* wood of commerce, which is highly aromatic and is much prized as incense and for the extraction of a fragrant oil.

(B) *Tropical Semi-Evergreen Types.* A Second group of this major type is the Tropical Semi-Evergreen Forest which occurs in a strip in the west coast and Anadamans and on a fairly wide area in the Assam Bengal-Orissa region, with an annual rainfall of over 1500 mm. (60 inches). On the west coast, *Vateria indica, Hopea parviflora* and *Xylia Xylocarpa* are the important species wherever these forests have been allowed to survive; Xylia is characteristic of the forests on laterite soils.

(C) *Tropical Moist Deciduous Types.* A third group of this important type is the Tropical Moist Deciduous forests. They occur- in Orissa, Bihar (Singhbhum) West Bengal (Buxa) and Assam (Kamrup). In the Andamans the moist deciduous forests are noted for the *Padank* (Pterocarpus delbergioides), a very durable, hard and ornamental timber of great value.

(D) *Moist Seral Types.* May be divided into the following types—

(a) *Tidal Forests.* A very large formation is to be found in the great delta formed by the Ganga and Brahmaputra before joining the Bay of Bengal. The most characteristic trees belong to the mangrove family. Characteristic genera are *Heritiera*, *Bruguisa*, Rhizophora, Ceriops; in places the low palm occurs along the edges of creeks. Tidal forests occur to a small extent also in the deltas of the rivers on the east coast. Elsewhere in India, much of the tidal forests at the mouths

of the rivers have been either ruined by over-use of cleared out for cultivation.

(b) *Fresh-water Swamps.* Of less importance are the fresh water Swamps in Uttar Pradesh, West Bengal and Assam where Barringtonia actangula survives Submergence during rains, with only the tops of the crowns sticking out of the water.

II. Dry Tropical Forests

The second important major forest type to be considered is the Dry Tropical Forests. They mostly occur in the rainfall zones of 750 to 1250 mm. They may be divided into the following main sub types—

(a) *Tropical Dry Deciduous Types.* Tropical Dry Deciduous forests are to be found on a very wide region around some of the major rivers (Ganga, Narmada, Tapti, Godavari, Krishna, Cauvery) and their tributaries. Species of Shorea robusta (Sal), Acacia Catechu (khair) and Teak are more important. Large tracts of this type have also been cleared for agricultural purposes and the forests in the neighbourhood have suffered from severe biotic factors such as over-cutting, over-grazing and fire.

(b) *Tropical Thorn Types.* The poorest forest sub-type is the Tropical Thorn Forest which is found in the desertic and arid portions of Rajasthan, Punjab, Western Uttar Pradesh, Gujarat and the Central dry region of the peninsula proper, which is situated in the rain shadow of the mountain systems bordering the trianagle. The most important tree being the *Babul* or Kikar which, however, in the driest regions exists only by the aid of river inundations.

(c) *Dry Evergreen Type.* These forests mostly confined to the east coast of the Peninsula from Madras north to Nellore (Andhra Pradesh), where unusual climatic conditions with rainfall chiefly restricted to the north-east Monsoon prevail. They are characterised by the great variety and luxuriance of their vegetation.

III. Alpine Forests

The Alpine forests occur at between 2900 to 3500 m. or even upto 3800 m. in places. In the North-western Himalayas, the chief timber is the Deodar, which occurs most commonly at an elevation of 1829 to 2438 metres. Towards its upper limit the Deodar merges into spruce and silver fir, while below it are found extensive forests of chir pine which is tapped for resin.

IV. Montane Temperate Forests

From an elevation of 2700 to 1800 m. and with a rainfall mainly of 1250 mm. to 2000 mm., we have the Montane Temperate forests.

This is the main coniferous belt of the middle latitudes containing Deodar, blue pine, oaks (Ouercus lamellosa, Q. Lineata, Q. Spicata etc.) hemlock (Tsuya brunoniana) and yew (Taxus baccata).

Economically unimportant Montane Temperate forests occur in the south at elevations of 1500 m. and upwards in the Nilgiri, Anamalai and Palni hills of Madras. They are also known as shola forests.

V. Montane Sub-tropical forests

This is the transitional stages between the Montane Temperate and the truly tropical vegetation round about an elevation of 750 to

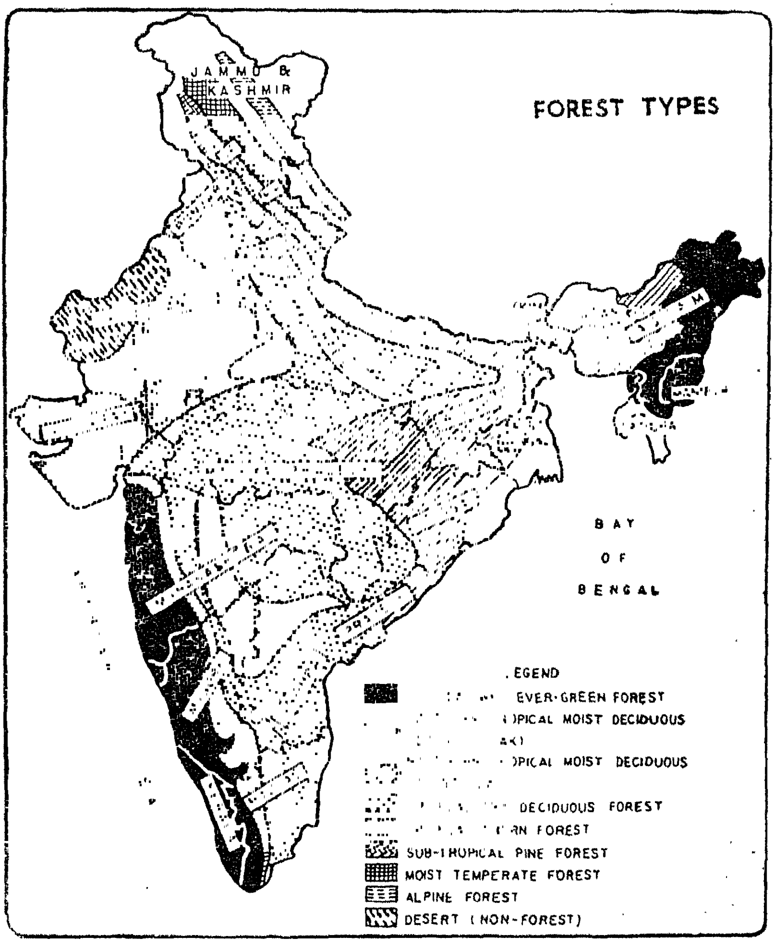


Fig. 17. Distribution of Forest Types in India.

1,800 m. in the Himalayas 900 m. to 1700 m. in the South (Nilgiri and Palni Hills etc.) and 1070 m. in the central region. In the eastern Himalayas and Assam these forests are characterised by various kinds of oaks, magnolias and laurels. In Assam "Khasia pine" grows abundantly at elevation of 915 to 2134 metres.

Fig. 17 shows the distribution of forest types in India.

The figures of forest area as a percentage of total land area and the per capita forest area relating to the various countries of the World are s follows :— (Table IX).

TABLE IX : *Forest as Percentage of Geographical Area**

Countries	Forest Area (million Hectares)	Percentage to Total land area	Forest area per Capita
U. S. S. R. ..	742.6	33.9	3.5
U. S. A. ..	252.5	32.8	1.8
Brazil ..	480.2	56.7	8.6
Africa ..	801.6	27.0	4.0
Japan ..	22.6	61.8	0.3
France ..	11.4	20.7	0.3
Italy ..	5.6	19.2	0.12
W. Germany ..	6.7	28.1	0.14
U. K. ..	1.6	6.5	0.03
Sweden ..	23.0	56.0	3.2
Finland ..	21.7	70.9	5.3
Spain ..	12.6	25.2	
India ..	73.3	22.3	0.2
Indonesia ..	121.0	63.5	1.6

Source ; *Unasylva, An International Reviews of Fo estry and Forest Products.* September, F. A. O.

The following table X gives the percentage of Land Area Under Forests and per capita forest Area in different States of India *—

States	Total Geographical Area	Total forest Area	% under forest	Forest ar a per capita
1. Andhra Pradesh	274,675	6,818	24.8	0.22
2. Assam	219,888	9,378	42.5	1.05
(a) Assam (excl. NEFA. incl. Naga land)	138,462	4,515	32.6	0.53

*Areas in thousand hectares

(b) NEFA.	81,426	4,862	59.7	9.71
3. Bihar	174,043	3,350	19.2	0.08
4. Gujarat	187,015	1,711	9.2	0.11
5. Maharashtra	307,773	6,711	21.8	0.21
6. Jammu & Kashmir	222,801	2,864	12.9	0.68
7. Kerala	38,857	1,259	32.4	0.07
8. Madhya Pradesh	443,434	18,247	41.1	0.70
9. Madras	129,843	2,138	16.5	0.07
10. Mysore	191,977	3,593	18.7	0.19
11. Orissa	155,819	6,562	42.7	0.45
12. Punjab	121,946	1,428	11.7	0.09
13. Rajasthan	342,268	4,339	12.7	0.27
14. Uttar Pradesh	293,846	5,787	19.7	0.09
15. West Bengal	87,873	1,225	13.9	0.05
16. Pondichery	481	..	..	..
Total for States	3,192,541	75,455	23.6	0.21
Union Territories—				
Andaman & Nicobar	8,328	648	77.8	215.7
Delhi	1,483	3	2.3	0.002
Himachal Pradesh	28,176	1,052	37.3	0.96
Lac., M. & Amin. Islands	28	..	..	..
Manipur	22,346	602	26.9	1.00
Tripura	10,453	637	60.9	1.06
Total for union territories	70,814	2941	41.5	0.73
Total for all India	3,263,355	78,396	24.0	0.22

India's forests cover 6.95 lakh sq. km., that is, about 24 per cent of the total geographical area of the country. The per capita forest area works out at only 0.22 hectares in India. Not only is the forest

area proportionately smaller in India but it is also unevenly distributed as follows—Table (XI).

States	Area Under forest (Areas in thousand hectares) Reserved	Protected	Unclassed	Total
Andhra Pradesh	4,780	1,294	744	6,818
Assam	2,583	28	6,766	9,378
Bihar	389	2,598	363	3,350
Gujarat	528	116	1,067	1711
Maharashtra	3,841	1724	1,146	6,711
Jammu & Kashmir	2,634	195	34	2864
Kerala	845	337	76	1,259
Madhya Pradesh	7,884	5832	4531	18,247
Madras	1,741	397	..	2,138
Mysore	2,356	694	543	3,593
Orissa	2,246	4,315	1	6,562
Punjab	56	1,245	127	1,428
Rajasthan	595	2849	895	4,339
Uttar Pradesh	4,430	323	1,033	5,787
West Bengal	718	397	110	1,225
Total for States	35,940	22,372	17,143	75,455
Union Territories—				
Andaman & Nicobar	388	144	116	648
Delhi	1	1	2	3
Himachal Pradesh	165	764	123	1,052
Manipur	100	222	280	602
Tripura	356	281	..	637
Nagaland	..	..	..	..
N.E.F.A.	..	..	..	..
Total for Union Territories	1,010	1412	520	2940
Total for All India	36,950	23,784	17,663	78,396

Most of the forests are concentrated in a few States, namely, Assam, Madhya Pradesh, and Orissa and in a few Union Territories like Andaman Nicobar, Himachal Pradesh, Manipur, Tripura etc. The per capita forest area works out at only 0.22 hectares in India, as

against 8.6 in Brazil, 5.1 in Australia, 3.5 in U.S.S.R., 3.2 in Sweden, 1.8 in U. S. A. and 0.3 in Japan and France. Table XII given below shows the area under forests in 1950-51, 1955-56, 1960-61 and 1961-62.

TABLE XII : *Area under Forests*

(Sq. kilometres)

Classification of forests	1950-51	1955-56	1960-61	1961-62
1. From out-turn point of view				
(a) Exploitable	5,84,599	5,64,938	5,09,807	5,27,091
(b) Inaccessible	1,33,431	1,38,725	1,64,154	1,52,333
Total	7,18,030	7,03,661	6,89,550	6,95,0133
2. By Administrative Classification				
(a) Reserved	3,44,405	3,59,468	3,16,091	3,12,292
(b) Protected	1,17,928	1,68,523	2,40,572	2,37,218
(c) Unclassed	2,55,697	1,70,241	1,12,095	1,24,551
Total	7,18,030	7,03,661	6,89,550	6,95,013
3. By composition				
(a) Coniferous	36,304	25,216	43,056	43,481
(b) Broadleaved				
(i) Soil	1,05,535	1,08,389	1,13,509	1,04,561
(ii) Teak	43,470	58,132	1,87,503	81,484
(ii) Miscl.	5,32,721	5,06,495	465,487	465,487
Total	7,18,030	7,03,661	6,89,550	6,95,013

The significance of India's forests, however, does not lie so much in the area, as in the fact that Indian forests produce some important products which are of great economic importance and which are not produced in other countries of the world. The essential oils and shellac are the products of Indian forests only.

Of 6,95,013 sq. km. of forest area, 5,27,091 sq. km. are merchantable and 152,333 sq. km. inaccessible. Forest area in India is by no means large when the vast population of the country is considered. To make the position worse a very large proportion of our forests is inaccessible for effective development and exploitation. For example, the vast forest resources of the Himalayas or of the Sunderbans cannot be tapped for want of good means of communication. It must

6

be remembered that the major product of the forest is timber which is a bulky and heavy commodity, and cannot be economically exploited without good transport. In some of the countries of Europe and America easy and cheap method of transport is provided by the winter snow which, hardening into ice, provides a slippery road for the logs. The logs are dragged to the river (which itself is frozen at the time), and floated down when the snow melts. Nature has not bestowed this advantage on us. The extraction and transport of our forest produce, particularly timber, is often attended with much difficulty in India and may involve engineering problems demanding a high degree of technical skill where the transport of timber is involved.

The methods of transport used in forest exploitation in India vary greatly according to local conditions, but fall naturally under the two main heads of land and water transport. Under land transport the following are common :—

(a) *Human Transport.* This includes, (i) the removal by head loads or otherwise fuel, etc., for short distances : (ii) the carriage of sleepers in the Himalayas from the forests down to slides or floating streams and (iii) the extradtion of heavy logs in the same localities with the help of rolling roads and slippery earth slides.

(b) *Animal Transport.* This includes the carriage of produce by carts where suitable roads exist or by pack animals such as the employment of elephants to drag heavy timber to floating streams, as in Mysore and the Andamans. Buffaloes are also used for this purpose and are cheaper than the elephants.

(c) *Mechanical Transport.* This includes tramways, rope-ways and skidders. Some of the most important forest tramways in India are those in Goalpara Division in Assam. Ropeways, worked principally by gravity, are used in various parts of the Himalayas (especially in the Changamanga area of the Punjab).

Transport by water includes wet slides to points from where sleepers can be floated : telescopic floating in small streams where there is not enough water, and ordinary floating, rafting and conveyance by boats. Water transport is used mostly in the Sunderbans and in Assam.

Causes of Slow Progress

While inaccessibility of our forests and backward transport are, no doubt, causes of the slow progress of forest exploitation in India, it must not be lost sight of that the demand for timber in India is not as great as in some of the industrialised countries of the West. In Europe and in America whole houses, from the roof down to the floor are built entirely of timber. Our climate will not permit this. Planks

are liable to crack in the scorching heat—even the small quantity of timber we use in our houses needs constant care. Besides, the rat and the insects considerably shorten the life of ordinary timber in India. We do not use as much furniture as the people in colder countries do. Our demands of timber are, therefore, less on this account also.[2]

Another difficulty, apart from inaccessibility and lack of demand for timber, in forest exploitation here is that very few types in Indian forests are gregarious to enable economic exploitation. Most of our timber trees (as for example Teak), grow mixed with other varieties which have no commercial importance. They do not occur in large stands. This involves a good deal of waste in exploitation and makes it very expensive in spite of the cheap labour available in India. We have very little pulping wood in our forests. Whatever pulping wood we have, occurs at great heights in the Himalayas where access is difficult. This is unfortunate for we cannot make use of this wood for making pulp for which there is a great demand. We must import the pulp from foreign countries, therefore.

Inaccessibility of forests, mixed growth of trees, lack of pulping wood and lack of a large market due to industrial backwardness of the country are the main drawbacks under which forest exploitation in India suffers.

India being mainly an agricultural country has been for ages dependent on forest products for many of its needs. It is estimated that forestry contributes 0.9% to the national income.

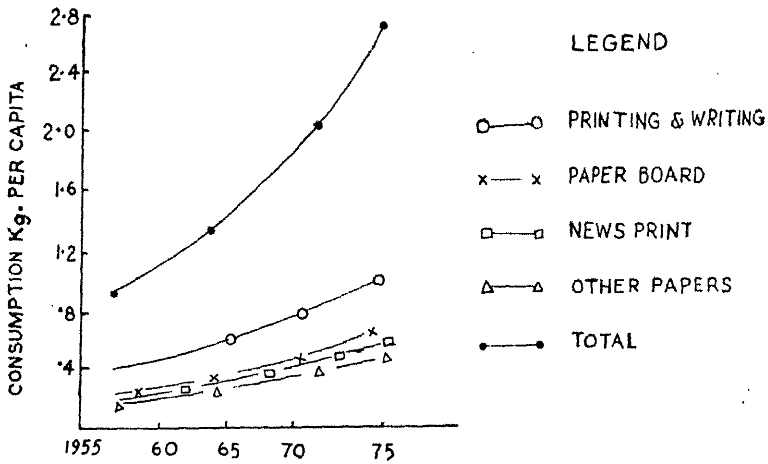


Fig. 18. Production of Paper and Board.

2. For example, India's per capita consumption of round wood is 1.4 cu. ft. as compared with the U. S. A. 58 cu. ft. The consumption of pulp products is 1.6 lbs. as against 78 lbs. in the U. K.

During the past decades, many industries based on forests or forest products have been established.

Among the industries established may be mentioned fire-wood and Charcoal, saw-milling, packing cases, cabinet-ware, boat-building, aircraft industry, textile auxiliaries, sports goods, battery separators, pencils, matches, plywood, building boards, paper and pulp, bamboo and cane articles, essential oils, drugs, tannis etc. Table XIII given below and figure 18 indicate the distribution of wood according to various requirements.

TABLE XIII ; *Estimate of the present and potential Requirments of industrial wood* (Period 1960-1975)

(Quantities are in thousands of cubic metres)
Figures in brackets are in tons of 50 cu. ft. each)

Group	1960 Quantity	1960 % of total	1965 Quantity	1965 % of total	1970 Quantity	1970 % of total	1975 Quantity	1975 % of total
Timber	2,550 (1,800)	45.82	3043 (2,150)	41.10	3,400 (2,400)	37.72	3,900 (2,750)	33.25
Plywood & boards	85 (60)	1.53	255 (180)	3.44	440 (310)	4.87	810 (570)	6.89
Mining	510 (360)	9.16	594 (420)	8.03	810 (570)	8.96	1,010 (720)	8.71
Transport & Communication	1050 (740)	18.83	1,170 (825)	15.77	1,275 (900)	14.14	1080 (765)	9.25
Wood working Industry	570 (400)	10.18	645 (456)	8.72	726 (513)	8.06	842 (595)	7.19
Packaging	540 (380)	9.67	690 (490)	9.37	850 (600)	9.43	1005 (710)	8.59
Pulp and Paper	57 (40)	1.02	170 (120)	2.29	350 (250)	3.93	1,560 (1100)	13.30
Rayon			570 (400)	7.65	850 (600)	9.43	1,130 800	9.67
Matches	210 (150)	3.82	270 (180)	3.63	310 (220)	3.46	370 (260)	3.14
Total major requirements	3,930	100	5231	100	6,363	100	8270	100

There is a large number of trees growing in Indian forests which produce good timber. The varieties that are commercially exploited, however, are limited. The most important varieties of trees that are at present exploited are the following :—

1. *Himalayan Silver Firs.* They are found in the north-western part and also in the eastern parts of the Himalayas at elevations from 7,500 to 10,000 ft. (2286 to 3048 metres). These trees are tall evergreen conifers, with soft white, not very durable, wood suitable for planking, packing cases, wood pulp and matches. They are at present worked to a small extent, though the quantity available is very large. They are more or less inaccessible at present.

2. *Deodar.* This is one of the most important timbers of India. It is a very large evergreen coniferous tree; a height of 90 to 120 ft. (28 to 37 metres) being usual. It grows in the Himalayas at elevations of 5,500 ft. to 8,000 ft. (1676 to 2438 metres) from Garhwal westwards through Jaunsar, the Punjab Hills, and Kashmir, between the outer wet ranges and the inner dry zones. The deodar forests avoid outer ranges and regions of high monsoon rainfall. They extend to an appreciably lower height on cool aspect. But on sunny ridges, they attain a greater height. The forest is nearly typically pure deodar, only a little spruce, and blue pine also being found. The workable area of deodar forest in the north-western Himalayas is about 2,000 sq. miles (3219 kilometers), but as in the case of the silver fir forests, the greater part of the deodar zone lies mainly in the Punjab. The deodar wood is yellowish brown, moderately hard, oily, strongly scented and very durable. It is used largely by the Indian railways for various purposes.

3. *Blue Pine* is another important conifer in India. It grows along the whole length of the Himalayas from Chumbi Valley in Tibet eastward. It grows at elevations of 6,000 to 12,000 ft. (1829 to 3658 metres). Pure stands of blue pine are commoner at the upper and lower limits than in the central part where mixed conifers predominate. Its wood is pink, moderately hard and of good quality. Its workable area is not large, though it is gradually coming into prominence. Most of the workings are in the Punjab.

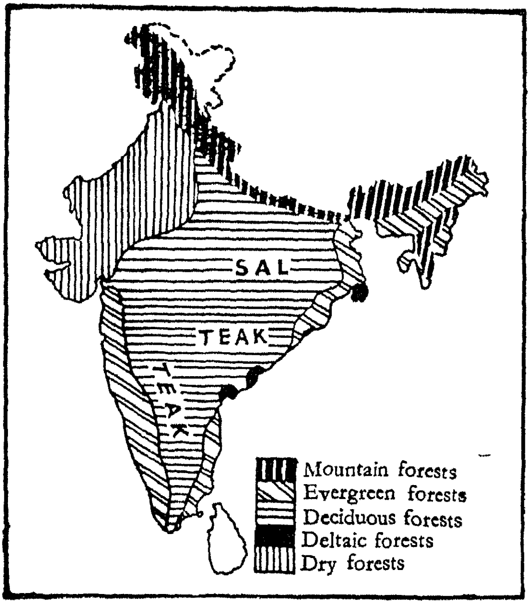
4. *Chir.* The chir is another large size conifer growing to a height of 60 to 100 ft. (18 to 30 metres). It occurs in the Himalayas from Bhutan westwards at elevations of 3,000 to 6,000 feet (914 to 1829 metres). The chir forest overlaps the tropical deciduous forest at the lower elevations; while it gives way to the temperate forest above. It is extensively developed in Kashmir, Punjab, U.P. and Nepal. The absence of the chir forest on the southern face of the outer range of the Himalayas is noteworthy, and is due to the combination of excessive heat with heavy monsoon rainfall. The chir wood is light reddish brown, and moderately hard. It is used largely for making tea boxes.

The workable area of the chir pine is about 3,000 sq. miles (4828 sq. kilometres) fairly equally divided between the Punjab and U.P. The chir is now extensively tapped in U.P. and the Punjab for the manufacture of resin and turpentine.

5. *Sal.* The sal tree is another important timber tree which has come into prominence, due to its large use for railway sleepers. The sal forests occur largely in the vicinity of the Ganga Valley which has the largest network of railways in India. It is, therefore, an added advantage for the exploitation of the Sal forests, as the railways can pay higher prices than building and other trades for the sal sleepers. The sal is a large gregarious tree found in Northern and Central India, in the Sub-Himalayan tract from Kangra to the Darrang and Nowgong districts of Assam and in the Garo Hills. It grows also in Chhota Nagpur, Orissa and the Madhya Pradesh. Sal wood is brown, hard and very durable, though somewhat coarse and cross-grained which seasons slowly. The working area of the sal forests in U.P. alone is about 3,000 sq. miles (4828 sq. kilometres) of which only a third is valuable, the rest being covered with inferior trees. The sal forests of U. P. which alone are exploited to any extent, are divided into three classes : the hill forests, the bhabar forests, and the terai and the plain forest. Of these, the finest are the bhabar forests. Outside U.P., good quality sal is found in Chhota Nagpur only.

6. *Teak.* The teak forests provided the most important timber in India when the Burmese forests were considered as Indian forests. Now, of course, its importance has gone, because the teak forests found in the present boundaries of India are not so fine as the Burmese teak forests. Teak forests occur mostly on the Western Ghats, Nilgiris and in Madhya Pradesh. Teak occurs either alone or mixed with other species. Pure forests of tea, are generally found on the lower slopes of the hills, or on alluvial flat along the banks of rivers; or at the bottom of ravines. On the higher slopes of hills, teak occurs mixed with other trees in the forest. The most important areas producing teak are in the districts of Hoshangabad and Chanda in Madhya Pradesh and Kanara and Khandesh in Bombay State. Teak forests are not found north of the Narbada river, nor east of the Mahanadi. There is a small export of teak wood from the Western Ghat area. Because of the high price that teak timber fetches, it has been planted in India more extensively than any other single species. The existing teak plantations in India are now estimated to cover an area of about 300 sq. miles (483 sq. kilometres).

7. *Babul (Acacia) and Shisham* which occur scattered over large areas in the drier parts of the country provide good timber for local use.



Fig, 19. Distribution of Forest types in India.

FOREST INDUSTRIES

Firewood and Charcoal are not only the primary requirements of any family, but are also required for various industrial purposes. About 2.632 lakh metric tonnes (2 lakh tons) of charcoal produced in Kerala State are said to be used by the tile manufacturers alone, and the iron and steel works and Sandal wood oil Factories in Mysore require 10,160—12,190 metric tonnes (10,000 to 12,000 tons).

Apart from providing charcoal and fire-wood, forests are also the source of a number of major products like paper, match, plywood pencils, packing cases, etc., which are essential for certain industries.

PAPER INDUSTRY

While the discovery of paper is attributed to the Chinese in 105 A.D., it was only during the Moghul period that paper was made in India. The first mill was started in India about a century ago in 1867. The paper industry today is one of the major industries.

During World War II, the number of mills increased to 15 and production reached 1,03,884 tons (1944). Rapid progress has been made since 1950. The installed capacity has risen to 5.54 lakh tonnes. The total capacity licensed so far is 11.28 lakh tonnes against the Third Plan production target of 7 lakh tons.

Owing to the backward state of education in the country, the consumption of paper in India is very low. The following table (XIV) shows the per capita consumption in India and some other countries of the world.

TABLE XIV : *Per Capita Annual Consumption of Paper in the world*

Country	Consumption (in Kilograms)
U.S.A.	199.47
Canada	127.0
U.S.S.R.	15.8
U.K.	106.6
Australia	88.5
Sweden	122.5
Japan	54.7
Argentina	35.4
Norway	87.0
Brazil	10.00
Newzealand	85.27
Switzerland	93.00
Pakistan	1.36
Italy	30.84
France	47.2
China	27.21
Mexico	15.00
India	1.11

The Indian figures approximate to those of Pakistan and are much less than those of the world as a whole and of most other countries. The industry had to pass through trials and the present distribution of the industry is shown in table XV below :—

TABLE XV : *Distribution and Capacity of Paper Mills and Board Mills (Capacity in metric tonnes per annum Figures in brackets are in tons)*

State	No.	Capacity
Andhra Pradesh	2	40,000 (39,000)
Bengal	5	97,000 (95,450)
Bihar	1	61,000 (60,000)
Gujarat	1	6,100 (6,000)
Kerala	1	8,800 (8,640)
Madhya Pradesh	1	5,500 (5,400)
Maharashtra	7	(30,400) (29,910)
Mysore	3	37,000 36,300
Orissa	2	73,000 (72,000)
Punjab	3	31,400 (30,900)
Uttar Pradesh	2	26,800 (26,400)
Total	28	417,000 (410,000)
	Newsprint	
Madhya Pradesh	1	30,500 (30,000)
	Board Mills	
Bengal	78	14,100 (13,900)
Gujarat	6	18,700 (18,400)
Madhya Pradesh	3	13,400 (13,200)
Maharashtra	4	12,600 (12,400)
Uttar Pradesh	6	19,800 (19,524)
Total	97	78,600 77,424

Raw materials form the bulk of the requirements of this industry. Roughly about 8 tons of these are required to produce 1 ton of paper. Luckily India has a large supply of raw material necessary for a prosperous paper industry. The Sabai or the Bhabar grass is the staple material for paper making in India. It closely resembles the Esparto grass of Africa which is so much in demand by the British paper industry. The greatest drawback of the Sabai grass is that it grows in tufts intermixed with other vegetation and it is difficult to separate impurities from it. Its supplies are also limited.

The supplies of bamboo, the other raw material of paper industry in India, are almost inexhaustible because of its quick and dense growth. The regeneration of wood-pulp forests takes about sixty years, while the bamboo forest is ready in a year or two. The quality of paper produced from the bamboo, however, lacks in strength. But the paper made from bamboo lack the bulking quality of Sabai grass paper and cannot so easily be used both for printing and for writing. On the other hand, both in finish and clearness of surface of writing it is greatly superior to grass paper, and does not compare unfavourably with the imported paper. For cheap varieties of paper rag, hemp, Jute waste and waste paper are also used. But necessary chemicals—Caustic Soda, Soda Ash, Salt Cake, bleaching powder and dyes are to be imported from abroad.

Most of the paper in India is produced in the neighbourhood of Calcutta which, with its large population, large number of presses and offices, offers the largest markets for paper. Good quality paper is manufactured from imported wood pulp. Wood pulp is also mixed with grass pulp to produce suitable paper.

The advantages enjoyed by the Bengal Mills are that they are very near coal supplies, large market and plenty of water from the Ganga. They have, however, to get the raw material from long distance.

The following table (XVI) gives the geographical distribution of existing paper mills in India.

TABLE XVI : *Distribution of Paper Mills in India*

State	Place	Installed Capacity	Total Productions
U.P.	Saharanpur	27000 tons yearly	80 tons per day
	Lucknow	4500 ,, ,,	3900 tons yearly
W. Bengal	Titagarh	N.A.	N.A.
	Kankinara	N.A.	
	Raniganj	N.A.	20,000 ,,

Gujarat	Badadadaji	6,000 metric tons	5.500 m. tons
	Nandaj	N.A.	20 tons per day
	Bilmora	12,000 tons yearly	N.A.
	Dhotikasurat	15 tons a day	3,600 tons yearly
Maharashtra	Vellarpure	36 tons a day	36 tons a day
	Vadavelli	1,800 tons yearly	—
	Khopoli	26 tons yearly	7,500 tons yearly
	Adhari	2,600 tons ,,	N.A.
	Bombay	5 tons a day	N.A.
Mysore	Bhadrawati	8,000 tons yearly	8,000 tons yearly.
	Dhandali	24,900 ,, ,,	25,000 m. tons ,,
	Belgola	35 tons per day	10,000 ,, ,,
Punjab	Jagadhari	120 tons per day	120 tons per day
Andhra Pradesh	Rajahmundry	2,800 tons yearly	200-250 tons per month
Kerala	Punalur	N.A.	4,000 tons yearly
M.P.	Nepanagar	30,000 tons yearly	25,143 metric tons yearly
Orissa	Koraput	18,000 tons yearly	N.A.
	Brijrajnagar	65,000 m. tons yearly	65,000 m. tons yearly.
Bihar	Dalmianagar	71,000 tons yearly	54,000 tons yearly.
	Darbhanga	18,000 metric tons	
Madras	Palli Palyam	60 tons daily	20,000 tons.

The effect of protection afforded by the Government in 1925 to the paper industry in India has been good. This can be seen from the fact that whereas in 1931-32 there were 8 paper mills producing about 40 thousand tons out of the total consumption of about 82 thousand tons in India, roughly about one-half, in 1936-37 there were 9 mills. Their production was about 48 thousand tons out of the total of 113 thousand tons consumed in India, less than half. The important point to note, however, is that before this latter year the Indian mills imported from abroad more than 53 per cent of the raw material they used, while in this year they used only 23 percent imported raw material. The following table (XVII) gives the production of paper in India from 1956 to 1962.

TABLE XVII : *Paper Production in India*

Year	Production (in tons)
1956	1,93,404
1957	2,10,132
1958	2,53,008
1959	2,94,024
1960	3,46,324
1961	3,63,912
1962	3,87,667

The noteworthy feature of the paper manufacturing industry of India has been the manufacture of almost all varieties of paper. The types of paper manufactured in India are white and unbleached printing other than newsprinting, writing paper, and envelopes, packing papers, pulp board, coloured printing paper etc. The production of certain types is clear from the following table (XVIII).

TABLE XVIII : *Varieties of Paper Production*

Year	Printing and Writing	Wrapping paper	Board	Special Varieties
1956	122,988	39,924	33,720	5,772
1957	126,516	29,016	28,400	7,200
1958	154,416	40,020	52,272	9,300
1959	187,420	65,608	55,688	5,328
1960	215,172	64,908	56,502	8,592
1961	227,548	50,856	65,532	8,676
1962	234,384	75,540	69,672	8,040

Newsprint

The first newsprint mill in India, the National Newsprint and Paper Mills Limited, Nepanagar (Madhya Pradesh), started as a private venture in 1947 and the responsibility for its management was taken over by the Madhya Pradesh Government in 1948. After its reorganization in 1958, the Government of India and the Government of Madhya Pradesh now hold shares of Rs. 2.55 crorers and Rs. 1.70 crores respectively. Total authorised and issued capital is Rs. 5 crores.

The mill went into production in January 1955. It has an installed capacity of 30,000 tonnes which is proposed to be increased to 75,000 tonnes. The Third Plan target is an installed capacity of 1.50 lakh

tonnes. The following table (XIX) shows the production of Newsprint in India.

TABLE XIX : *Newsprint Production*

Year	Production ('000 tons)
1955-56	3.45
1957-58	14.14
1959-60	22.41
1960-61	23.40
1961-62	25.27
1962-63	26.51
1965-1966 January	25.27

Recently licences have been given for starting 7 new mills, whose installed capacity would be of the order of 551,000 tons per annum. Of these 3 mills are to be located in Bombay and one each in Andhra, Bengal, Assam and Orissa. Licences have also been granted for the expansion of the existing 8 mills, so as to increase their capacity to 109,500 tons annually.

Under the Third Plan the productive capacity of paper and paper board industry was expected to go up from 4.1 lakh tons to 8.2 lakh tons and production from 3.5 lakh tons to 7.0 lakh tons. The productive capacity of newsprint industry will rise from 30,000 tons to 150,000 tons and the production is expected to rise from 25,000 tons to 120,000 tons.

Saw Mills. The saw mills industry is distributed throughout the country. Assam is said to have started a mill as early as 1884, for making tea box shooks. The industry is distributed almost throughout India. There are besides many small units scattered about. The industry is still in its infancy and requires modernization with a view to avoid waste. The saw dust is at present mainly sold as fuel.

Matches

The match industry is a very important one, as it not only deals with an every-day commodity, but is also a good collector of revenue to Government at little cost. Rs. 9 crores is said to be the revenue collected in 1961. The industry was established in 1922, 60% of the country's requirements are made in factories, the rest by the cottage industry. This is almost localized in the Shivakashi and Ramnad Districts of South India, where about 50,000 workers are employed. 25 species have been considered suitable by the Indian Standards Institution and the Institution has investigated the suitability or

otherwise of 93 species. There are over 50 factories distributed throughout the country.

The largest production of matches is in the neighbourhood of Calcutta where Indian wood is mostly used. The Indian wood is used in Calcutta *Genwa*, though *papita* and *dhup* from the Andamans are also used; *didu* and *bakota* also come from the Andamans. *Genwa* is available in large quantities in the Sunderbans. The next important centre for the industry is Bombay where the wood is imported. But there are some factories in Gujarat and other parts of Bombay where Indian woods are used. These woods are *simul*, mango and *salai*. These woods do not grow in large quantities at one place. Plantations of *simul* have now been undertaken by some factories. *Simul* is very good for box-wood, but is inferior for sticks. In fact, there is no Indian wood, except perhaps the mango, which is as good for splints as the imported aspen. The chief centres of this industry are Bareilly, Gwalior, Hyderabad, Ahmedabad, Ambarnath, Calcutta, Madras, Shimonga, Petlad, Dhubri and Trivandrum.

The following table (XX) gives the distribution of existing match factories in India :—

TABLE XX : *Match Factories*

Bengal	4	Calcutta.
Maharashtra	2	Bombay , Thana, Poona, Chanda.
Gujarat	2	Ahmedabad, Ambarnath, Petlal.
Madras	3	Ramanathampuran, Chingleput, Tinnevelly.
U.P.	7	Meerut, Bareilly.
Mysore	1	Shimonga.
Kerala	6	Trivandrum.
Andhra Pradesh	9	Hyderabad, Warangal.
Assam	2	Dhubdi or Dhubri
Rajasthan	1	Kota
M.P.	3	Bilaspur.

The total amount of matches produced in India in 1958 was 614, 000 each containing 50 gross boxes of 60 sticks each. The production is increasing under the protection of Government. The imports of matches have now practically ceased. The Swedish Match Industry which was the greatest supplier of matches to India has built its own

factories here and imports most of the raw materials from Sweden or Finland.

The following table (XXI) shows the production of match in India since 1950.

TABLE XXI : *Production of Match in India*

1950	523,200 cases
1951	578,400 ,,
1952	619,200 ,,
1953	618,000 ,,
1954	529,200 ,,
1955	615,600 ,,
1956	589,000 ,,
1957	577,000 ,,
1958	614,400 ,,
1959	648,000 ,,
1960	660,900 ,,

Sports Goods

The Punjab and Kashmir States are the home of the sports goods industry which was mainly situated in Sialkot. After Independence the industry has moved to Jullundur and Meerut.

Both in Uttar Pradesh and Punjab there is a quality marking scheme and the industry is guided by the government. The industry has an export market. The following table (XXII) shows the distribution of sports goods industry with its main centres.

TABLE XXII : *Distribution of Sports Goods Industry*

State	
Uttar Pradesh	Meerut, Lucknow, Agra, Kanpur, Allahabad and Nainital make Cricket bats, Hockey Sticks, Tennis and Badminton rackets.
Punjab	Mainly in Jullundur willow is used.
Maharashtra	Small-Scale
Jammu and Kashmir	Only Cricket bats at Miransahib, Jammu.

MINOR PRODUCE

The importance of Indian forests lies in the exploitation of minor produce, some items of which are in demand all over the world. The importance of our minor forest produce is not so much in the present stage of development as in its future possibilities. Bamboos, some of the grasses, oils and, tanning materials produced in our forests are cap-

able of providing inexhaustible supplies of industrial raw materials. Unlike timber, new supplies of these raw materials are quickly brought into existence. Table XXIII shows the value of minor forest produce during the years 1950-51, 1955-56, 1960-61 and 1961-62.

TABLE XXIII : *Value of Minor Forest Produce*
(in thousand Rupees)

Year	Bamboos & canes	Fibres & flosses	Gum and resins	Other minor Products	Total
1950-51	1,52,00	52	41,93	4,98,03	692,48
1955-56	1,36,78	43	1,01,42	5,63,11	801,74
1960-61	2,16,99	43	2,04,78	6,90,75	11,12,95
1961-62	2,41,86	55	2,05,93	7,62,27	12,10,61

A large variety of industries is based on minor forest products. The production of tanning material in 1960 was estimated as equivalent to 20,300 metric tonnes, which is likely to double by 1975.

Katha and Cutch Industry. The Indian Katha industry is largely in the hands of small-scale manufacturers scattered all over the country. Katha and Cutch are extracted from the heartwood of *Acacia Catechu* (Khair). No regular statistics are available for the production of Katha by the small-scale manufactures; about 2,000 to 2,500 tons of Katha are produced annually by this sector of the industry. The organized sector, which is largely concentrated in the States of Bombay, Uttar Pradesh and Madhya Pradesh, produces 1,000 to 1,500 tons of Katha and 4,000 to 4,500 tons of Cutch annually. The total production of both Katha and Cutch is valued at Rs. 20 to Rs. 30 millions.

Rosin and Turpentine Industry. Rosin and Turpentine industry figures prominently in the chir pine forests of the western Himalayas (Jammu & Kashmir, Punjab and Uttar Pradesh).

Rosin is an important industrial raw material as it is used in the paper, soap, surface-coating and disinfectant industries, over 10,000 metric tonnes of rosin and 2,700,000 litres of turpentine are produced annually in three government-owned factories in Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh. Production is insufficient to meet the growing demand at present.

Essential Oils

Among oils, the Sandal Oil is the most important. The following essential oils are being produced on a large scale in India at present.

TABLE XXIV : *Production of Essential Oils in India*

Essential oil	Plant from which derived	Annual Quantity in metric tons	Production Value in millions of rupees
1. Sandal wood oil	Santalum album (wood)	101.6 (100)	10.5
2. Lemon grass oil	Cymbopogon Citratus , C. Flexuosus	..	..
3. Citronella oil	Cymbopogon nardus	..	..
4. Palmarosa oil of ginger grass oil (Rusa oil)	Cymbopogon martini	90 (90)	1.6
5. Vetiver oil	Vetiberia Zizanioides (Steam)	8 to 10 (8 to 10)	..
6. Linaloe oil	Bursera delpechina (wood and fruits)		
7. Eucalyptus oil	Eucalyptus globulus (leaves)	15 to 20 (15 to 20)	..
8. Geranium oil	Pelargonium	..	..
9. Cinnamon oil	Cinnamon Zeylanicum (bark)	..	..

Besides the above, large quantities of attar of roses, jasmines and pandanus, etc., are distilled and absorbed on Sandal-wood oil; also floral waters of rose, pandanus, aniseed, spearmit, etc. The scope of essential oils is so extensive that it practically embraces many spheres of human interest; they are used in the manufacture of products like Soaps, Cosmetics and toilet preparations, perfumes, disinfectants and antiseptics.

Lac Industry. Lac is of economic importance to India. It is also the main cash crop of tribal population of India. In recent years it is facing keen competition from Synthetics. Lac is especially used in wood working, insulation moulded components, grinding wheels, paper laminates etc.

During 1954-55 the total produce of timber and fuel amounted to a little over 15,82,00 thousand cubic feet valued at Rs. 21,67,84 thousand. The minor produce during the same period fetched 7,73,87,000 rupees.

During 1961-62 the total produce of timber and fuel amounted to a little over 1,45,48 thousand cubic metres valued at Rs. 50,13,75 thousand. The minor produce during the same period was Rs. 12,10,61.

Table XXV shows the quantity and value of timber and firewood produced during 1950-51, 1955-56, 1960-61 and 1961-62.

TABLE XXV : *Production of Timber and Firewood.*

(Quantity in thousand cubic metres)

Year	Timber	Round wood	Pulp & match wood	Fire wood	Charcoal wood	Total	Total value (thousand Rs.)
1950-51	29,92	8,37	13	1,11,66	7,81	1,57,89	19,08,07
1955-56	33,94	7,20	42	92,33	15,76	1,49,65	27,68,82
1960-61	45,26	7,53	47	1,13,35	2,81	1,69,44	49,17,07
1961-62	42,00	10,21	215	1,03,48	4,03	1,61,87	50,13,75

The minor forest products of India which are commercially important are bamboos and canes, fodder and grazing, gums, resins, lac, grasses other than fodder grasses and products which are of use in perfumery or medicine. Four of the above products, namely, lac, myrabolans, gum karaya and beedi leaves, occupy positions of considerable importance in India's external trade. Reliable data about internal consumption and carry-over of stocks from year to year are not available.

The main importance of the forest in India is, however, as a source of grazing and fuelwood that it provides. India is a country where there are no grasslands to provide grazing to animals. Forests are, therefore, a great help for keeping animals. India does not use much coal as a domestic fuel. Wood fuel is, therefore, a great necessity. Forest is fundamental in Indian economy; more than in any European country, on this account. In India, according to 1961 livestock census, there are 17.5 crores cattle, 5.1 crores buffaloes 6.0 crores goats and 4.0 crores sheep. With a geographical area, which is 2.2 percent of that of the world, and a population, which is 13 per cent of that of the world, India has 19% of the world's cattle, 50% of the world's buffaloes and about 18% of the goats.

The following table XXVI gives the livestock statistics.

TABLE XXVI : *Live-Stock Population*

Animals	1945 (in Lakhs)	1951	1956	1961	% increase of 1961 over 1951
Cattle	1367	1,552	1,589	1,757	10.7
Buffaloes	407	434	449	512	13.9
Sheep	377	390	392	403	2.6
Goats	463	471	554	608	9.8
Horses and Ponies	13	15	15	14	6.0
Other Livestock	69	79	81	73	9.3
Total	2,684	2,926	3,065	3365	9.8

For the reason that forests are too far away for the vast majority of the animals, only 11.5 percent of the total live-stock of the country are able to graze in forests. Where, however, forests are available nearby, the local cattle depend mainly on forest grazing to an extent, in fact, that causes serious damage to the more accessible peripheral forest areas. The extent of such excessive grazing and the damage done thereby vary from State to State.

ADMINISTRATIVE CLASSIFICATION

With a view to better exploitation and protection against destruction, the Indian forests have been classed under (i) Reserved, (ii) Protected, and (iii) Unclassed forest. The Government of India is paying attention to the systematic development of Indian forests, and apart from the usual administrative machinery for protecting and working the forests, there is a Forest Research Institute at Dehra Dun to tackle scientific problems dealing with Indian forests.

Realising the usefulness of forests in checking soil erosion, the Government has planted new forests in some of the ravine lands of the Chambal and the Jamuna. Under the 3rd Plan a long-term plan to extend the area under forests has been formulated. The following measures are envisaged :—

(i) The rehabilitation of about 4.0 lakh acres of 'degraded' forest which have come under State control.

(ii) Plantation along canal banks and roadsides and on village wastelands as shelter belts.

(iii) Plantations of commercially important species like *teak* as forest land, of *wattle* and *blue-gum* on about 13,000 acres and of medicinal plants on about 2,000 acres.

(iv) match-wood plantations on about 50,000 acres;

(v) Construction or improvement of 12,000 kms. of forest roads;

(vi) The establishment of timber treating and seasoning plants;

(vii) The survey of forest resources and adoption of better techniques of timber extraction. A forest Research Centre has been set up at Bangalore.

(viii) Plantations of commercially important species like *teak* as 50,000 acres of forest land of wattle and *blue-gum* on about 13,000 acres and of medicinal plants on about 2,000 acres.

Van Mahotsava was inaugurated in 1950 with the object of making the people conscious of the value of trees in the country's economy. During the first three years of the Van Mahotsava about 12 crore trees were planted by the people, of which about 60% have survived.

Schemes have also been prepared for the immobilization of the Kutch desert and the afforestation of the U.P. and Rajasthan deserts. It has been proposed to create a green belt on the western border of Rajasthan about 55 kilometres long and 7 kilometres wide.

Extraction of Andaman timber is now being increasingly done to meet home and foreign demands.

QUESTIONS

1. What are the characteristics of Indian forests ? How far are geographical factors responsible for them ?

2. What factors lead to the growth of grass at the expense of forests in India ?

3. What are the causes of the disappearance of the closed forests from the plains in India ?

4. What are the main forest types in India ? Where do they occur ?

5. What is the main forest produce in India ? What are the main areas of production ?

6. What is the importance of minor produce in Indian forests ? Where is the produce mostly found ?

7. What are the drawbacks in the way of forest exploitation in India ?

8. What is the importance of Sal and Deodar forests in India ?

CHAPTER 5

Soils

"Soil is a natural body developed by natural forces acting on natural materials. It is usually differentiated into horizons of mineral and organic constituents of variable depth which differ from the parent material below in morphology, physical properties and constitution, chemical properties and composition, and biological characteristics."

The soil is a natural medium for plant growth. Soil supplies nutrients for growing plants, and plants manufacture feed for animals and food and fibre for man.

Soil is a priceless resource from which we obtain our food, clothing and other necessities of life. Soil undoubtedly is the greatest asset of a nation. It is the basis of our economic stability and the source of our national strength. With a fast growing population and a rapidly expanding economy, constantly increasing demands are continuing to be made upon the land. We have, therefore, to conserve our soil and maintain its fertility in order to keep our economy sound, our people nourished and our nation strong. When the soil is lost, prosperity and culture of the country are also lost. The nation dies. This has happened in several parts of the world.

The dependence of the bulk of our population is on agriculture, and therefore, study of Indian soils is of great interest. Unfortunately, very little systematic work has been done in the study of Indian soils. The data available, therefore, are meagre.

The effect of the rock as well as of the climate on soils in general is clear. Wadia[1] and others have made an outline study of the influence of geology on Indian soils.

There are five principal factors of soil formation, *viz.*, 1. parent material, 2. climate, 3. vegetation, 4. relief and 5. time. Climate, aided by vegetation which it fosters, acts upon the parent material. The action of these two factors is conditioned by local relief or topography. The length of time during which these factors are operative further influences the character of the ultimate product. The factors are thus inter-dependent, each modifying the influence of the other. Climate, however, is the most dominant factor. It is responsible to a very large extent in influencing the nature of a soil. While the differences due to

1 Wadia, *Soils of India*, Records of the Geological Survey of India, Feb. 1935.

parent material and relief are more or less local, those due to climate cover large areas. At first the parent material, on weathering, produces a distinct kind of soil, but as time goes on, the distinction between soils derived from different parent materials situated in a climatic zone gradually disappears. Each climate together with its vegetation and other biological activities that promotes, imparts its own special characteristics to the soil, no matter what the original parent material may have been.

Climate influences soil formation both directly and indirectly. Directly it affects the weathering of rocks and the transportation and redeposition of the products of weathering. One of its most important effects is its influence on the movement of water in the soil through percolation, leaching, runoff, *etc.* It is largely this direct effect of climate which is responsible for the development of the soil. Many of the products so formed are true soils, but some of them are the parent materials from which new soils are now developing. Indirectly it influences soil formation through the activities of plant and animal life. Relief also plays an important part in controlling the effect of climate in soil formation by influencing the air-water regime in the soil.

The Indian Council of Agricultural Research is tackling the study on the basis of climate. The Council has come to a tentative conclusion that according to the influence of rainfall the soil zones of India run north-south. It cannot, however, account, on the basis of climate, for the fact that certain soils assimilate the fertilizers much more quickly than others.

Soil Classification

The fundamental purpose of soil classification and mapping in the Indian Republic is to gain a better knowledge and understanding of the origin and properties of soils and their distribution as part of the general advancement of soil utility upon which the economy and prosperity of the people ultimately depend. The most important problem in India today is to ensure that the people of the country will be fed. To deal with the inevitable increase in food consumption due to rising populations we must have precise knowledge about the geographical extent and location of different soils, and determine how may they best be used and, at the same time, preserved for posterity.

The two major types of soil are *residual* and *transported.* The first one is derived *in situ* from the rocks present in the area and the second is brought in the flowing water or wind from elsewhere. The soils in river valleys, deltas and mountain valleys belong to the second type, while those of the other areas are mainly of the first type.

First Classification of Indian Soils

The Indian Council of Agricultural Research, Delhi, divides the soils of India into the following main classes.[2] This classification depends on climate and rainfall as well as the drainage characteristic of the area.

(1) *Red Soils.* The red soils are not always necessarily red in colour though frequently they are light red to brown. These soils are extensively developed over Archaean Gneisses and are generally deficient in phosphorus, lime and nitrogen. They are moderately fertile for agricultural purpose.

(2) *Black Soil.* It is the well-known "black cotton soil" or Regur soil. It is fairly widely spread on the Deccan Traps and on some areas of Gneissic and calcareous rocks, as for example in Andhra Pradesh and in the central and northern districts of Maharashtra and Mysore. Black Soil is a clayey to loamy soil composed largely of clay material.

(3) *Lateritic Soil.* It is fairly common in the areas occupied by the Deccan traps and some Archaean gneiss, particularly in the western Ghats of Mysore and Kerala.

(4) *Saline and Alkaline Soils.* Alkaline soils are characterised by the presence of appreciable quantities of calcium (lime) and Sodium compounds. Saline soils, on the other hand, contain various amounts of hydrogen which replaces calcium and Sodium.

Saline and Alkaline soils are extensively distributed throughout India in all the climatic zones. Many parts of the dry tracts of the north, especially in Bihar, U.P., Punjab and Rajasthan, give rise to Saline and alkaline efflorescences, which are harmful for crops. It has been estimated that about 21 lakh acres in U.P., 5 lakh acres in the Punjab and about 67 thousand acres in Maharashtra have been affected by *Usar.*

(5) *Peaty and Marshy Soils.* These soils generally originate in humid regions as a result of accumulation of large quantities of organic matter. They are black, heavy and highly acidic and are found in Kerala. Marshy soils are met within the coastal tracts of Orissa, Sundarbans and some parts in Bengal, North Bihar and South-east Coast of Madras.

(6) *Alluvial Soils* do not really form a definite group. They represent both transported and residual soils which may have been re-worked to some extent by water. Most of the alluvial soils are found in valleys and deltas and some may be present in forest and semi-desert areas also.

(7) *Desert Soils.* These soils are mostly found in arid regions under conditions of poor water supply.

2 Report of All India Soil Survey Scheme, Bulletin No. 73, 1953, Delhi.

(8) *Forest Soils.* Forest Soils' formation is governed mainly by the character of the deposition of the organic matter derived from the forest growth. The soils occur in the hill districts of Assam (they contain high proportion of organic matter and Nitrogen), in U.P., in the Sub-Himalayan tract and in Coorg (Mysore).

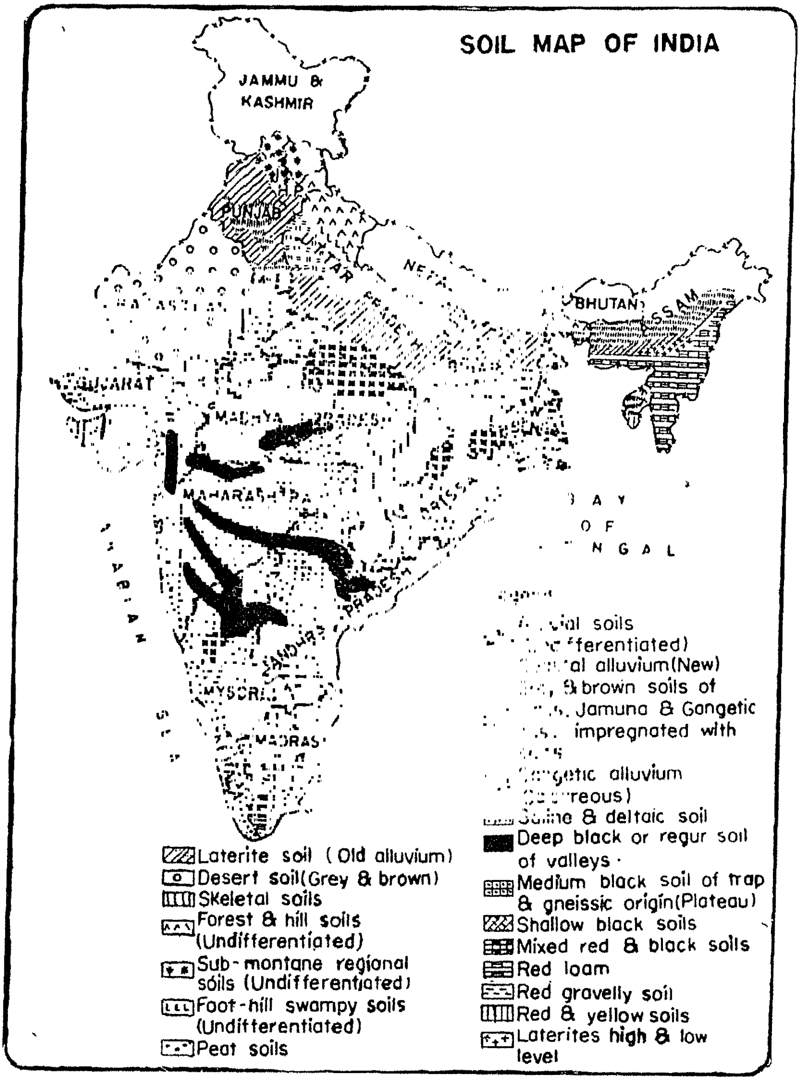


Fig. 20. Soil Map of India.

The soils of India offer a distinct contrast to those of many other countries, inasmuch as they are very old, fully matured, and do not in many cases show pedogenic processes and the close relationship between the soil and its rocky substratum. The weathered materials in most cases have been transported to great distances by various agencies. The majority of the soils in India are of ancient alluvial origin. Their examination shows that although the nature and composition reflect to some extent the composition of the original rocks from which they are derived, they are the result to a considerable extent of the climate, particularly the amount and seasonal distribution of rainfall. The monsoon rainfall and the high temperatures that prevail in India, considerably affect the character and sub-aerial denudation of the surface rocks. Compared to the soils of temperate zones the soil temperatures in India are 10 °C. to 20 °C. higher, and therefore, all chemical reactions involved in the formation of soils proceed many times more intensively. The high temperatures and humidity function so intensively that chemical decomposition follows almost at the heels of rock disintegration. This feature is particularly conspicuous in the soil formation in the plains in India.

Under climatic conditions where precipitation exceeds evaporation, the percolation of water downwards through the soil layers causes considerable leaching. In this process the soil bases, particularly lime, are removed from the surface and their place taken by hydrogen, thus forming acid soils. In such cases, the farmers add lime to the soil to remove its acidity. This practice of 'liming' is not very common in India.

Second Classification on Parent Rocks

Soils can also be classified according to the parent rocks from which they have been derived, but in such cases the transported soils will have to be studied in relation to the areas from which they were originally derived.

The soils of extra-Peninsular India are further subdivided into—

(1) Soils of Sutlej-Ganga and Brahmaputra Plain.

(2) Soils of Montane.

On Geological basis, the Indian soils fall into two broad divisions; the soils of the extra-peninsula and the soils of the Peninsular India.

SOILS OF EXTRA-PENINSULAR REGION

The soils of the Sutlej-Ganga Plain are mostly alluvial. They are classified as sand, clay or loam, which have been derived from the debris brought down from the Himalayas or from the silt left, as in the

case of Rajasthan, by the old sea which has now retreated. These soils are the deepest, finest, and therefore, the most fertile in India. They consist mostly of loam which is a mixture of clay and sand. The proproportion of clay in the loam increases in the renewed alluvium, *e.g.*, nearer the deltas of the most important rivers. The character of the soils of the Sutlej-Ganga Plain depends upon the part of the valley where they occur. The soils are the coarsest in the upper section, medium in the middle section and finest in the lowest section of the valley. Sand, being the coarsest, naturally predominates in the upper courses of the rivers, while clay, being the finest particle of the soil, marks the lower courses. Locally sand or clay may occur in any part of the valleys provided there be an elevation where sand may be deposited, or a depression where clay may be deposited by the flood waters.

In the upper courses of the rivers sand predominates, being continually renewed by the floods from the Himalayas. Pebbles and large stones are also found mixed with it, specially in the river fans known as Bhabars. The soil in this section is, therefore, not fertile. In the middle courses of the rivers, deepest alluvium occurs in which clay predominates in depressions. The soil here is the most fertile. In the lower courses of the rivers, finer alluvium in which clay predominates is the rule. The depth of alluvium in this part is not much, but the fertility is great due to the frequent renewals of soils. The fertility of these alluvial soils of the north is due more to the mixing up of the debris derived from new rocks of the Himalayas rather than to the prevalence of nitrogenous matter or humus. The alluvial soils are composed of material drawn from different rocks and therefore, contain a great variety of salts. This varied nature of salts in these soils is the basis of their great fertility. The alluvial soils respond quickly to the use of manures. They are also easily tilled and are, therefore, the best agricultural soils of India.

Predominantly sandy ridges logically known as *bhur*, or alkaline stretches known as **reh** or **kalar** or **usar** are a feature of these soils. In clayey areas nodules of concentrated lime known as **kankar** also appear near the surface. Such **kankar** deposits are especially marked in Bihar and the eastern parts of U. P.

Besides the alluvial soils, there are some areas in the Punjab where wind-borne soils (**loess**) have covered the alluvial soils. These loess soils are very fine-grained and highly porous.

The alluvial soils of the Sutlej-Ganga Plain as of other parts of India also lack in the nitrogenous matter. For example, the soils of the Punjab have been found to contain only from 0.025 p.c. to 0.100 p.c.[3] of nitrogenous matter as compared to about 20 p.c. in the best steppe soils of Russia. The Indian soils, however, recoup their losses

3 See Pugh and Dutt, *Crop Production in India*, p. 75.

of the nitrogenous matter much more quickly than the Russian soils can do. They are capable of fixing nitrogen very rapidly through leguminous crops.

The alluvial soils of the Sutlej-Ganga Plain are rich in potash, phosphoric acid, lime and organic matter but are deficient in nitrates and humus contents. These soils are of marvellous fertility producing[4] under irrigation splendid crops of rice, sugarcane, tobacco and jute.

The soils of Sutlej-Ganga and Brahmaputra Plain are subdivided into—

(1) Alluvium Soils.

(2) Calcareous Alluvium Soils.

(3) Chestnut Brown Soils.

(4) Saline and Alkali Soils.

(5) Terai Soils.

(6) Desert Soils.

Alluvium Soils. These soils are a very large group of soils formed by transportation by streams and rivers and deposition over the flood plains or along the coastal belt. These soils represent the vast tracts of riverine alluvium of the Sutlej-Ganga plain. The deposits of the great rivers : the Jamuna, the Ganga and their tributaries the Gandak, Gomti, Ghagra and others, which flow out of the Himalayan ranges have accumulated over long periods in the northern part of the Sub, continent. The alluvium deposits of the plain can be classified under two Sub-divisions—old (bangar) and new deposits (khadar).

Calcareous Alluvium Soils. The calcareous soils have developed on the alluvium brought by the river Gandak flowing from the Himalayas in a north-west to south-east direction towards the Ganges. These are alluvial soils which occur characteristically along the north-eastern districts of Uttar Pradesh and extending to the north-western parts of Bihar.

Chestnut Brown Soils. These soils also come under the broad group of alluvial soils. The soils are deficient in phosphate, with medium status in organic matter and nitrogen. The old Indo-Gangetic alluvium of the north-west region of India has been subject to varying climatic conditions from humid to arid, as the distance from the Himalayas increases. These also extend to Punjab, north-western parts of Uttar Pradesh.

Saline and Alkali Soils. These soils occur in Uttar Pradesh, Bihar, Punjab and Rajasthan. The soil commonly known as 'Usar' or reh. Patches of 'Usar' and 'reh' soils are common in the Tons-Sarju-Gomti Interfluve. The soils affected by alkali have a high pH., which may range between 9.0 and 10.5, and the exchangeable sodium may be over 15% of the total exchange capacity.

4 Mamoria, C. B., *Agricultural Problems of India*, 1953, p. 46.

Terai Soils. The soils of the Terai region lying at the foot of the Himalayan ranges possess certain characteristics of their own, which makes it necessary to denote them separately on the soil map of India. (See fig. 20).

These occur all along the foot-hills in the northern parts of Uttar Pradesh, Bihar and West Bengal, and are fairly deep, moderately fertile soils. The whole region of Terai is made up of debris and soils brought by the streams. The river coming from the mountains have to cross the Bhabar region and the big as well as smaller boulders and debris which they brought is left and deposited there, because due to the comparatively gentle slope the carrying power or velocity of the streams and rivers lessens only the finer material is carried away by them until it also is deposited when terai is reached. This process of deposition might have been in active operation since centuries past. The coarser sediments was deposited in the Bhabar region and the finer one in that of Terai.

Desert Soils. The soils are found characteristically in the arid zone in the north-western region in the States of Rajasthan and the Punjab and lying between the Indus River on the west and the Aravalli Range of Hills on the east, are described as Desert Soils. Some of these soils contain high percentage of soluble salts and varying percentage of calcium carbonate and are poor in organic matter. The limiting factor is mainly water, and reclamation is possible only if proper irrigation facilities are made available.

2. Montane Soils

On the basis of the available geological data five main soil types have been recognised in India, *viz.*, the brown hill soils, the grey brown, the red and the black and glacial soil.

Brown Hill Soils. The soil throughout the mountain is brown in colour. The true colour of the soil is due to the decomposition of the crystallines *in situ*, and is always thin. This soil is very retentive of moisture, which is the main cause of their exceeding fertility. The brown soils covering a widely dispersed tract differ greatly in consistency, depth and fertility. Their characteristic feature is the red-tint. By intermediate stages they vary from the poor, thin, gravelly and light-coloured soils of the uplands suitable for the cultivation of poor crops.

Red Soils. Red is in many respects similar to brown; it is of a lighter colour, is more mixed with sandy particles, is not quite so productive as the former in its best seasons. Grey is mixed with sandy loam, but of very partial distribution.

The colour varies from brownish or reddish yellow on the highest pebbly uplands to grey or dark grey in the lowest clayey lands. The

thickness of the soil varies from zero on the rocky exposures to several metre in the low lying situations.

Grey Brown. These soils occupy a significant role among the soils of hills. This soil mainly occurs in areas where the pine trees are found in abundance. The texture of this soil depends mostly upon rainfall. This soil becomes very hard during the summer and cannot be ploughed until the rains fall.

Black Soils. The Black soil in hill is found in the deciduous forests. The black colour of this soil is due to the fallen leaves and grasses which mingle with the soil. This process of plant decay makes this soil extremely fertile. This soil is sometimes found as an exception south of the deciduous forests. This soil has a great moisture holding capacity. The black soil is rich in humus.

The other region of the occurrence of black soil in the area where the volcanoes frequently used to occur in the geological past. For this region the soil contains many mineral elements.

Glacial Soils. Another kind of soil, found in the mountain, has been probably made up of morains. This soil is found only in those parts, where the snowfall takes place in abundance and the ground remains covered up with snow for three months in a year. This soil can be named as Till or glacial soil. With the approach of Summer, the snow begins to melt and the melt water brings with it the soil and deposit it in the valleys. The fertility of this soil is also great because of its mineral content.

SOILS OF PENINSULAR INDIA

Most of the soils of the Peninsula are 'diluvial' as opposed to 'alluvial' soils of the north. The diluvial soils remain in the area where they are formed and thus there is no mixing of different rock, materials. The fertility of the diluvial soils depends on the chemical constituents of the rocks from which they are derived. The soils of the Peninsula have been classified as under :—

1. 'Regur' or the Black Cotton soil of India.
2. Red or yellow soils.
3. Laterite soils.
4. Mixed Red and Black soils.
5. Alluvial soils of the deltas.

1. The *Regur* or the *Black Cotton* soil has been derived from the old lava deposits and is among the most fertile soils of India. It is also known as the *Trap Soil*, as the lava deposits trapped or covered

the original rocks. It is so rich in plant food that it has been cultivated for thousands of years without the use of manure. Its main area extends from Bombay in the west to Amarkantak in the east and from Guna in the north to Belgaum in the south. In this area the black soil attains its greatest depth which is about twenty feet in its deepest parts. The greatest fertility of the soil occurs in such parts. Near the margins and on the slopes the soil is thin and the rocks buried under it generally appear on the surface. Apart from this main area the Black Cotton soil is found also in scattered areas all over the Peninsula *e.g.*, in Bundelkhand, in Tinnevelly district of Madras, and near the Aravalli hills. The Regur of India is similar to the black soils of Arizona in the United States of America which, too, have been derived from the lava. It is, however, different from the black soils of Ukraine in Russia or the Prairies in North America whose black colour is due to the presence of large quantities of vegetable matter in them. These latter are, therefore, friable and easy to till, while the Indian soil is sticky and very difficult to work, particularly when it is wet.

In some parts of the Peninsula, as in Gujarat and Madras, the origin of the black cotton soils is ascribed to old lagoons in which the rivers deposited the materials brought down from the interior of the peninsula covered with lavas.

Krebs[5] holds that the Regur is essentially a mature soil which has been produced by relief and climate, rather than by a particular type of rock. According to him this soil occurs where the annual rainfall is between 50 to 80 cms. and the number of rainy days are from 30 to 50. The occurrence of this soil in the Western Deccan where the rainfall is about 100 centimetres and the number of rainy days more than 50, is considered by him to be an exception.

These soils are highly retentive of moisture and extremely compact and tenacious. They are rich in iron, lime and alumina. They are poor, however, in phosphorus and organic matter. The amount of potash in them is variable, but it is not much. Thus it will be seen that these black soils are poor in those chemicals in which the other soils of India are rich. These soils are specially suited for cotton, wheat and linseed, etc.

The colour of these soils has been ascribed by some scientists to an organic compound of iron and aluminium. The greatest agricultural drawback of these soils in India is that they crack into deep fissures when dry. They also cake and harden, making ploughing difficult.

The fertility of the black soils is due to their retentivity of moisture; fineness and chemical matters; specially lime.

---

5 Krebs, *Climate and Soil Formation in South India, the Lzeit, Erdkunda*, Berlin 1936.

The black soils of Peninsular India are further sub-divided into—

Shallow Black Soils, Medium Black Soils and Deep Black Soils.

Shallow Black Soils are derived from basalts of the Deccan traps. The soil is usually silty loam to clay in texture, and the surface has a colour ranging from dark brown to dark yellowish brown. Territorially, they comprise the greater part of Betul, Hoshangabad, Chhindwara, Narsimhapur in M.P. and Nagpur, Wardha, Bhandara district of Maharashtra.

Medium Black Soils. These are black soils with depths ranging from 50 to 120 cms. and developed from a variety of rocks including basaltic traps, Dharwar Schists, basic granite, gnieisses, hornblende and Chlorite Schists. Medium black soil is especially well developed in Maharashtra, North-west Madhya Pradesh, Northern Mysore, N.W. Andhra Pradesh and Central Kutch.

Deep Black Soils. Cotton is the important commercial crop grown on these soils, these are also referred to popularly as the "Black Cotton Soils". Deep black soils are met within the central parts of Broach Surat, Nasik, Bhir, Ahmedabad, Khandesh, Krishna, Chitraldruga etc.

2. The *red* or *yellow soils* are characteristic of rocks in which large quantities of iron are present. Under uniformly high temperatures the iron disintegrates and is spread uniformly in the soil, giving it a red or yellow colour. These soils are, therefore, common in the Tropics. Their main stretch in India is south of the Tapti, though they occur in scattered areas even to the north of the Tapti and in Assam. They are found associated generally with the Eastern Ghats. These soils are highly porous and are fertile only where they are deep and finely grained. They are generally poor in nitrogen, phosphorus and humus. They are poor also in lime.

3. The *Laterite soils* are highly infertile and are marked by barren reas where there is no vegetation. They are red in colour and coarse. tony gravel marks their outer surface. Though red, the laterite soils are to be distinguished from the other red soils. They are composed of a little clay and much gravel of red sandstone rocks. The laterite soils are, as a rule, very poor in phosphoric acid which is the most important plant food. Laterite soils are formed under high rainfall which removes silica from them leaving behind hydrates of alumina in them. Laterite is especially well developed on the summits of the plateaux and the hills of the Deccan, Madhya Pradesh, Ragmahal, the Eastern Ghat regions of Orissa, South Maharashtra and Kerala, and parts of Assam.

4. *Mixed Red and Black Soils.* In areas of black soils, occurrence of patches of red soil are not of unusual occurrence. The occurrence of red and black coloured soils side by side in areas of varying sizes and

unpredictable patterns is a fairly common feature in transitional area where either of these soils are found. The soil is mostly well developed in Banda, Hamirpur, Jhansi in U.P., Tikamgarh, Panna, Chhatarpur, Satna, Rewa, Raigarh in M. P. and Singhbhum district of Bihar State.

5. The alluvial soils of the deltas are generally silt derived from the flood water of the rivers. Most of the rivers of the Deccan take their rise in the Black Soil area from which they carry large quantities away to the delta. The general characteristics of these soils are similar to those of the Sutlej-Ganga Plain.

The Coastal alluvium of Peninsular India are further subdivided into :—

Deltaic Alluvium and Coastal sand.

The soils of the Deltaic alluvium represent the heterogeneous types of sediments brought by rivers and deposited at the mouth of the great rivers. The east coast of Peninsular India is characterised by the formation of deltas at the mouth of the major rivers of the sub-continent that flow into the sea. These rivers carrying the alluvium of the extensive areas they traverse, deposit them at the regions where they join the sea, and these deposits form the alluvial soils of these deltas.

Coastal Sand. Found mostly in coastal belt all along the peninsular region and extending for varying widths between the sea and the range of hills along the east and the west coasts. Some areas in the low-lying flat lands can be marshy and saline, in which case the swampy condition makes the areas unfit for any useful cultivation. These sandy stretches, if the ground water level is not too deep, are only used for raising the full trees.

SOIL FERTILITY IN INDIA

Indian soils are classed among the fertile soils of the world. This does not mean that the yield of crops from them is necessarily very high : it only means that they are suitable for crop production. High yields of crop always go with intensive farming, implying efficient manuring at suitable intervals. No soil, however fertile it may be, can show large yield without the addition of suitable manures.

Maeriker classified soils into various classes on the basis of fertility as follows :—

Content of Plant Food in every 10,000 *lbs. of the Surface Soil*

Class of Soil	Nitrogen	Phosphoric Acid	Potash
Poor Soil	5 lbs.	5 lbs.	5 lbs.
Normal Soil	15—25 ,,	10—15 ,,	10—15 ,,
Good Soil	24—40 ,,	15—25 ,,	15—25 ,,
Rich Soil	over 40 ,,	over 25 ,,	over 25 ,,

"Indian soils, like all tropical soils in general, are very deficient in organic matter and nitrogen. The phosphate deficiency is comparatively less marked, while potash deficiency is rare."[6] The system of agriculture in India has been adapted with this deficiency in view. The pulses, like *arhar* and *urad*, and the oilseeds, like groundnut are used in our agriculture largely to supply nitrogen to the soil. These crops manufacture nitrogen from air at their roots through certain bacteria and thus enrich it to some extent. The poverty of the Indian cultivator does not enable him to use chemical fertilizers to supply nitrogen to the soil. Lack of fuel wood in sufficient quantities in the villages also diverts from the soil to the kitchen fire this very valuable animal manure.

It has been felt that there is an urgent need for promoting the use of green manures and nitrogenous fertilizers on a large scale in all parts of the country. Application of these, especially in conjunction with phosphatic fertilizers has been found to increase crop yields very considerably. The use of green leaves and wild leguminous plants serves very well the purpose of enriching the soil.

During 1961-62 the demand for nitrogenous fertilizers amounted to about 26.70 lakh tons in terms of ammonium sulphate while their availability, including internal production and imports, was estimated at 15.0 lakh tons. As usual, in 1962-63 the demand for nitrogenous fertilizers increased further while increase in the supplies was only about 70 per cent.

In 1960-61 an area of 115 lakh acres was green manured and it was estimated to rise to 150 lakh acres in 1961-62.

In 1961-62, about 2950 thousand tons urban compost were prepared in 2135 urban centres and about 2560 thousand tons distributed. In 1962-63 the production was estimated at 3100 thousand tons. Schemes for the utilization of sewage and sullage were in operation in 70 important towns and cities. They utilized about 20 crore gallons of sewage and sullage water per day for irrigating about 25000 acres.

Soil fertility of a high order is dependent on sound cultivation practices and the use of soil conserving crops. Faulty cultivation methods and inadequate crop rotations can lead to deterioration of soil tilth on susceptible soils and ultimately to some degree of crop failure because of imperfect seed germination and inadequate intake of moisture. Such soil damage also leads to the appearance of wind and water erosion, particularly of sheet and gully erosion on sloping land.

SOIL EROSION

The term erosion, as used in this portion of the chapter, means the loosening and removal of soil from its previous resting place by the

6 M. S. Randhawa, *Op. Cit.*, p. 30.

action of water. In India, soil erosion is in many places a serious menace. The rapidity with development has occurred has often led to the employment of agricultural methods conducive to erosion and, in consequence, large tracts of land in India have already been rendered unproductive, while much larger tracts are threatened.

The extent to which erosion is liable to occur will vary with the conditions, but at any point its incidence is determined by the following factors—

(1) The configuration, and particularly the slope of the land.

(2) The erodibility of the soil,

(3) The amount, distribution and intensity of the rainfall,

(4) The vegetable cover,

(5) The system of husbandry and soil management practised.

(1) *Topography and Slope of Ground are important factors in erosion.* Although soil-erosion is frequent throughout the country, it operates most intensely in the hilly regions. The precipitation often occurs in torrents which instead of sinking into the ground, as the light drizzles do, washes away the top layers of the soil. The steep slopes of the hills further stimulate the eroding power of the rain water. The soils are very thin and all exposed slopes are susceptible to serious sheet erosion or gullying. Erosion may be of little consequence for hilly tract but is of great significance to the plains. The whole basin of Kosi river is threatened by this erosion, as a result of which the rivers bring with them millions of tons of sand and detritus annually. When the rivers reach the plains and below and the stream flow slackens the load is dropped and gets deposited in their beds. This leads to choking of river channels which in turn increase the flood danger and induces shifting of the course which brings disaster in its train to the whole country-side.

The river Chambal has cut more deeply than the smaller streams into this great mass of Archaean formations, and the most rugged topography is found in its vicinity. The smaller streams must, of course, cut to practically the same depth to reach the Chambal.

(2) *The Erodibility of Soil.* Both surface erosion and deep gullying are considerably influenced by the type of soil in India, although a given soil type may not behave consistently under all conditions and no type of soil is entirely safe from erosion. Thus sandy porous soils in country are in general least subject to gradual weathering-down by water-action. Since they are capable of absorbing a great amount of water in ordinary rains. On the other hand, if the rate of percolation is prevented by frost or by even thin strata of clay, the very lack of "binding" qualities in the sandy soils permits them to be moved at a very rapid rate. Again, however, the coarseness of the material may

cause it to be deposited before it has been carried any great distance.

(3) *The Amount of distribution and Intensity of Rainfall.* As regards rainfall, Tempany writes, "it is not so much the amount of rain that falls during the year that is important, but rather that how it comes and when it comes. A single heavy fall of rain in a few hours may occasion very severe soil losses and damage, while the same precipitation distributed over an interval of several days or weeks can occasion little harm..... The rate of movement of water depends upon the slope of the land. Other things being equal, the steeper the slope the more rapidly does water run down it, and rapidly moving water has great erosive power. Theoretically, if the rate of flow is doubled, the scouring capacity is increased four times, the carrying capacity thirty-two times, and the size of the particles carried, sixty-four times."

Amount and rate of rainfall directly affect erosion. Data are not needed to convince even the most casual observer that heavy and rapid downpours are much more likely to cause erosion than equal quantities of rain falling over longer periods. This is so generally fixed in the lay mind that the local language has been fitted to express the relationship. Thus a slow, steady rain (rimjhim varsha in local dialect) is commonly called a "ground soaker" while a dashing rain (bochar) is in many localities referred to as a "gully waster".

(4) *The Vegetable Cover.* The most potent and common causes for erosion in India are deforestation and overgrazing. Throughout the country, as population has increased, more and more forest has been destroyed, mainly by grazing, cattle feed on grass and herbs and green bushes. Their numbers are never limited to the fodder available. For grass to grow and persist in the face of grazing, the climatic conditions must be such that rain falls in light showers at intervals. Whereas throughout the lesser Himalaya and foothills, the bulk of the rainfall occurs in two and a half months of the summer monsoon. Then there is a flush of grass and the cattle get enough to eat; but during the long periods of drought, the grass is grazed to the ground and torn out by the roots by the hungry cattle. When the drought is broken by storms the top-soil is washed away from the bare pastures and they deteriorate. Excessive grazing in Rajasthan not only destroys the grass but compacts the soil, and many pastures, ruined by the hoofs and teeth of countless hungry animals, are pastures only in name.

Under a natural vegetative cover, a certain amount of erosion takes place; but the rate of soil formation largely balances the loss. "Under a cover of natural vegetation erosion is restricted to the geologic norm", that is, the rate of soil formation is generally at least as great as that at which it is washed away. Removal of the natural vegetation, particularly if accompanied by cultivation, may lead to very rapid soil losses.

(5) *The system of husbandry and soil Management practised.* In agricultural land of India crops vary widely in their effect on erosion losses. Unsuitable methods of cultivation and the absence of precautions to ensure the conservation of soil may lead to severe losses from erosion. The first step is to stop the type of misuse of land which has caused the trouble, whether this be deforestation, fire, overgrazing or excessive cultivation of steep slopes.

Nothing is more serious among the agricultural problems of India than the lack of realisation of the loss that the country is suffering through soil erosion. Thousands of tons of good soil are being washed away every year to the sea without the slightest attempt being made to check it in some measure. This loss is greater in India than in most other countries, because of the nature of the Indian rainfall. The huge rainfall of the country which ultimately causes great floods in the big as well as the small rivers of India carries away large quantities of soil from one part to the other, and finally to the sea. The extensive areas of the ravine lands in the neighbourhood of rivers are a sufficient proof of this. The pity of it is that we ourselves lend a helping hand to the running water to carry away our soil.

The problem of soil erosion is a complicated problem. For soil erosion varies from place to place according to the character of the soil, according to the slopes of the ground, according to the vegetation cover, according to the use to which the soil is being put, and according to the nature and the amount of rainfall. The solution of the problem lies, therefore, not in any one fixed method but in adopting several methods that will take into consideration all the above factors. The main object is to retard the speed of run-off. Planting of trees, regulating grazing, building of dams across the ravine lands, and contour[7] terracing are some of the methods that have been followed in foreign countries to check soil erosion.

SOIL CONSERVATION

In general terms, soil erosion is caused by water running from higher to lower levels over the surface of the ground. Soil conservation, therefore, means either decreasing or diverting the runoff, or both. "Soil conservation in its widest sense includes not only control over erosion but all those measures like correction of soil defects, application of manures and fertilizers, proper crop rotations, irrigation, etc., which aim at maintaining the productivity of the soil at a higher level." In this last section of this chaper, however, we are concerned only with the measures for control over soil erosion, which is one of the most serious problems facing the country.

7. Contour terracing means making a level terrace on elevated ground sunning in the direction of the contour and not across it. Thus, the water in the terrace flows only slowly and does not cause excessive erosion.

India's various methods of soil conservation have been carried out by farmers for centuries. The methods are not scientifically designed nor are they systematically applied. Often they are successful though imperfect; they have been developed on sound principles but they need improvement and extension. Thus the possible methods are—

(1) Terraces control runoff and reduce erosion.
(2) Contour Cultivation.
(3) Crops and Crops practices.
(4) Increased use of manures.
(5) Keeping the soil covered.
(6) River embankments.
(7) Control of rock washes on steep slopes.

Terraces Control Runoff and Reduce Erosion. "One of the most common methods of reducing runoff velocity is to break a slope by terracing." Terracing is the oldest known method of stopping erosion in hills.

Contour Cultivation. Ploughing along the contours on the sloping lands reduces considerably the soil loss by erosion and the total annual run off increasing thereby the crop yields. In some localities of Kerala, plantation is on ridges mostly down in horizontal row. This method has been proved effective in reducing runoff and erosion in Nilgiri.

Crop-Rotation. The aim of the farmers in crop rotation should be to keep the land under protective cover for as greater a proportion of the total time as possible, lessening thereby the soil loss by erosion.

Crop rotations are followed in India for the following reasons—

(1) In order to maintain productivity and yields.
(2) Systematic farming.
(3) It helps to control weeds, insect pests and plant diseases.
(4) It helps in maintaining organic matter and nitrogen.
(5) It lessens soil loss through erosion.
(6) It keeps the soil occupied with crops for most part of the year in India.

Increased use of Manures. Through manuring the Indian farmers can check the deflection of soil nutrients which takes place with continuous cropping. Manures can be animal and plant residues, artificial fertilizers or green crops. They ensure yet another aspect of soil conservation, *viz.*, the building up of soil productivity.

Keeping the Soil Covered. Grasses are even more firm protectors of soil than the trees; but the grasses too are destroyed by over grazing,

making the earth bare of any vegetation. Here we do not mean that the animals should not at all be allowed to graze, but they must be prevented from overgrazing. Overgrazing in the local grasslands must strictly be prohibited. To solve the problem of animal fodder, green grasses should be grown in the fields when they lie fallow. This will result in stimulating the fertility of the soil as well as solving the fodder problem.

River Embankments. The swift flowing rivers of India often overflow their banks in the rainy season and due to the greater slopes their velocity is intensified and the eroding power increases. Many smaller rivulets erode every year thousands of tons of fertile soil which is wasted for nothing.

Soil conservation actions would substantially affect the agricultural practices. Colin Maher has very aptly observed that "Soil conservation can only be successful if it is related to improved husbandry, including a rotational system with grass leys and the maintenance of soil fertility and soil structure by all the methods known to the good husbandman. Soil conservation methods which are not based on this are waste of time and money and will not have lasting results in preventing the deterioration and ultimate ruin of the land."

An outlay of about Rs. 72 crores has been provided for the execution of various soil conservation programmes as against Rs. 1.6 crores in the First Plan and Rs. 18 crores in the Second Plan.

Contour bunding and terracing were carried out over an area of 7 lakh acres of Agricultural land during the First Plan and 20 lakh acres during the Second Plan. The Third Plan envisaged the extension of these operations to 110 lakh acres. The number of demonstration projects for the popularisation of dry farming techniques were undertaken during the Second Plan. Work on such projects has been extended during the Third Plan so as to cover an area of about 2.2 crore acres. In 1961-62 new dry farming projects were started in addition to the 40 already established during the Second Plan.

Afforestation and other soil conservation measures in the catchment areas of river valley projects were carried out over about 1.40 lakh acres during the Second Plan. An allocation of Rs. 11 crores has been made in the Third Plan for extending this programme to another 10 lakh acres.

Other soil conservation programmes during the Third Plan include reclamation of about 2 lakh acres of water-logged, saline and alkaline lands in the Punjab, U.P., Mysore, Gujarat, Maharashtra, Rajasthan and Delhi and about 40,000 acres of ravine lands.

Under the All India Soil and Land Use Survey Scheme an ares of 20.03 lakh acres had been surveyed till September 1961 as againta the target of 25 lakh acres for the year 1961-62.

QUESTIONS

1. In what respects do the soils of the Peninsular India differ from those of the Indo-Gangetic Basin ?

2. What are the characteristics of the Regur Soils of India ? How do they affect the agriculture of the region ?

3. Give an account of the soils of the Indo-Gangetic Valley.

4. What is Soil Erosion ? Suggest some methods for checking it in India.

CHAPTER 6

Animal Husbandry

India's economy being still largely agricultural, the importance of live-stock in the national economy needs no special emphasis. According to the 1956 Livestock census, there were 306 million farm animals. Of these, cattle numbered about 159 million and buffaloes about 5 million, constituting together a fourth of the world's bovine population.

There were, in addition, 39 million sheep, 55 million goats, 8 million other animals and 95 million poultry. The annual contribution rom livestock to the national income is about Rs. 1,500 crores representing about 15% of the total.

Live-stock Census

The State-wise population of live-stock as per the census of 1956 is given in table XXVII.

In India, according to 1961 livestock census, there are 17.5 crores attle, 5.1 crores buffaloes, 6.0 crores goats and 4.0 crores sheep. The llowing table XXVIII gives the live-stock statistics for India.

TABLE XXVIII : *Livestock Population (in Lakhs)*

Animals	1961
Cattle	1,757
Buffaloes	512
Sheep	403
Goats	608
Horses and Ponies	14
Other Livestock *i.e.*, donkeys, mules, pigs etc.	73
Total Livestock	3,365

It thus possesses 19% of the world's cattle, 18% of the world's goats; 40% sheep and more than half the buffaloes.

TABLE XXVII : *Live Stock in* 1956.

State	Cows & Bulls	Buffaloes	Sheep	Goats	Horses Ponies	Mules	Donkeys	Camels	Pigs
Andhra Pradesh	11,276,547	5,967,638	7,846,250	3,693,412	31,514	382	76,429	107	620,845
Assam	5,308,748	520,665	168,640	1,051,140	15,382	243	281	..	504,620
Bihar	14,398,399	3,426,450	1,051,342	6,524,732	119,064	1,407	34,411	1,567	684,638
J. & K	1,757,466	374,147	1,465,381	813,503	79,028	5,459	11,249	1,291	409
Kerala	2,510,376	487,653	97,820	955,570	1,690	2	1,415	..	113711
M.P.	22,639,701	5008,517	901,015	5,218,949	253,156	1,760	58,411	11,293	356,866
Madras	9,698,251	2,040,944	7,041,616	3,757,582	123,942	243	94,648	74	506,903
Mysore	8,965,693	2,668,713	4,059,473	2,583,991	43,591	329	58,508	423	185,493
Orissa	7,862,439	828,777	1,078,736	1,642,739	72,939	9,888	366	118	121,080
Punjab	5,948,138	3,809,693	1,229,929	1,910,835	97,160	616	145,204	227,114	88,364
Rajasthan	12,072,713	3,439,449	7,372,805	8,730,163	112,636	500	190,327	436,237	72,030
U. P.	23,021,827	9,797,897	1,906,314	6,272,627	352,194	13941	197,717	50898	1,143,422
W. Bengal	11,108,156	788,601	611,519	4,268,160	25,000	161	438	6	205,047
Gujarat	3,415,150	26,40,061	17,43,506	26,05,502	1,01,824	523	1,21,329	43565	
Maharashtra	141,60,784	26,97,355	19,59,347	45,83,399	1,39,840	535	54,511	968	1,64,327
Union Territories									
Delhi	120,310	115,229	22,036	7,281	634	1194	71193	1914	24828
H.P.	1,170,761	205,964	651,623	5,520	697,176	3446	2378	100	12,204
Manipur	267,722	52,295	12,621	213	1578	..	..	..	82,298
Tripura	302,865	40,477	101,332	646	6774	3	11	5	40,095
And. & Nic.	3,915	35,2.8	4,475	17	34	..	..	..	14,449
L. M. & Am. I.	602	..	1095	..	653	..	..	..	..
Total for all India	158,650,624	44,915,758	39,246,248	55,405,490	1,482,737	40,386	1,118,821	775,680	4,931,968

Importance of Cattle in National Econoy

An immense wealth of livestock is possessed by India. Unfortunately, the productive capacity of Indian animals is extremely poor. Cattle and buffaloes occupy a premier position among the various species of livestock; and unlike in other countries, cattle are an integral part of our agriculture.

Cattle provide us with milk and milk products. The productivity of India's livestock is generally low. Although high individual yields of milk are obtained in some breeds of cattle and there is evidence of a slight increase. India's average yields continue to be extremely small. Thus the average milk yield per lactation of cows is around about 400 lb. and of buffaloes a little above 1100 lb. compared to about 5000 lb. or more in advanced western countries. The total production of milk which was estimated at about 17 million tons in 1951 and at about 19 million tons in 1956, is at present reckoned at about 22 million tons.

The dairy industry or other forms of animal industry, like meat-packing, have not developed on any large scale in India. The urban population which offers the largest market for these industries is not large. The number of animals yielding milk is, however, very large. These animals are kept for breeding bullocks and buffaloes that are needed for agricultural operations. Their main purpose, therefore, is not milk production but to help agriculture. Cattle play a very important part in Indian agriculture. According to Russel, "But unlike in other countries of the world, whose cattle are maintained mainly for milk and meat, in India these are primarily kept as draught animals for the plough or the cart as the camel, the horse, the donkey and mechanical vehicles are rarely used. Without them no cultivation would be possible, without them no produce can be transported."

The milk yielded is used mostly for making *ghee* which is sold in cities. The quantity of ghee made is estimated to be about 12 lakh maunds. Of the total milk produced in India, about 38% is estimated as being used for consumption as fluid milk, about 42% as *ghee* and the rest as butter, khoa, curd, and other products. For want of large grazing areas, the dairy cattle are generally stall-fed. This is particularly so in large cities like Calcutta and Bombay. The largest number of milk yielding animals is in U.P., where the area under cultivation is the largest in India, and therefore, the need for cattle help is very great.

Cattle serve in transport too. According to the Royal Commission on Agriculture, "In most parts of the world cattle are valued for food and milk; in India their primary purpose is draught for the plough and for the cart...."

Cattle also provide the farmyard manure which promotes the productivity of the soil. One cow usually provides with 122 mds of dung and 40 mds. of urine per year.[1]

1. *Rural India*, Vol. 19, No. 2, 1956, p. 80.

The animal most used for slaughter for meat is the goat. The largest number of goats are in U.P., and Madras. The number of sheep in India is 39 million, but owing to the hot climate they do not produce good or fine wool here. In the Himalayas, where alone good wool is produced in India, the goat is more important as a wool producer than sheep. They provide 72 millions lb. of wool, about one-half of which is exported as carpet wool.

Other products such as hides and skins are the important source of income from cattle. India produces about 32% of the world's hides and skins. Various estimates have been made regarding the contributions which cattle make to the nation. The estimates range from Rs. 1,011 crores (by Dr. Wright) to Rs. 1,200 crores (Sir Datar Singh) and to Rs. 3,470 crores (by Srinivasan). The following table XXIX shows the total income by animal husbandry in India.

TABLE XXIX : *Products and Income by Animal Husbandry in India*

Ttem	Crores Quintals	Crores mds.
Milk—Cow	7.72	20.7
She Buffaloes	9.48	25.4
She Goats	0.63	1.7
Ghee	0.41	1.1
Butter	7.46	20 lakh mds.
Meat		4.6 lakh tons.
Egg		1.41 crores
Hides-Cattle		1.6 crores
Buffaloes		0.5 ,,
Skins-Goats		2.1 ,,
Cow		1.6 ,,
Wool		6.5 ,, lbs.
Profit in terms of Rupees—		
Milk and Milk Products		800 crores
Ploughing and other Agricultural Practices		1200 ,,
In a form of transport		300 ,,
Meat		120 ,,
Hides and Skins		50 crores
Cattle manure		1000 ,,

1. Shrinivasan, N. S., *Cattle Wealth in India*, 1953.

Cattle Breeds

There are at present forty recognised breeds of cattle and buffaloes in our country. ertain breeds of cattle are known for their high milk production, while others for their high class powers. A third category of animals combine in themselves a moderate degree of efficieny for production of both milk and work. The farmer in India keeps cattle primarily for the purpose of draught for the plough or the cart, although in most parts of the world food and milk are the primary purposes for which they are kept.

Some of the best varieties are mentiond here—

(1) Some of the best cows in India are *Sahiwal* in Punjab and *Gir* in Mahrashtra. *Red Sindhi* whose habitat is in Sind (now in Pakistan) has been developed in Coorg (now in Mysore) and at Government farms of Karnal, Hosur and Kolla. It is a *milch* breed and cows are one of the best and economical producers of milk.

(2) The important breeds of bullocks are *Hissar* and *Hansi* found in Punjab and Nellore in Andhra Pradesh. *Amrit Mahal* is one of the best draught breeds found chiefly in Mysore State. Bullocks of this breed are active and fast trotters. *Ongola* bullocks are powerful and suitable for any work. Home of this breed is Nellore and Guntur districts of Andhra Prashde. Other breeds are *Kanrej* in Gujarat, and *Kangayam* in Madras. Where the treasury business is done by the state, *Kherigarh* in Uttar Pradesh, *Dungi* and *Nimar* in Bombay and Hariana in Punjab. The finest dual purpose animals, *i.e.*, best for draught as well as milk purposes are *Kanrej* and *Gir*.

The best breeds of buffaloes are *Murrah* in Punjab. *Jafferbadi* in Saurashtra and *Mehasana*, *Surati* and *Pandharpuri* in Maharashtra.

These nine breeds of cattle from all parts of India are of first rate importance—

(1) *Sindhi.* This breed hails from Sind, but several pedigree herds of it have been established in India, particularly in Kathiawar on the west coast. It is a distinctive dairy animal.

(2) *Sahiwal.* Though originally belonged to central undivided Punjab, it is available in Karnal, Uttar Pradesh and Madhya Pradesh.

(3) *Hariana.* The home of this breed is the area covered by the districts of Rohtak, Hissar, Gurgaon, part of Karnal and the Delhi State. This breed is also produced in more or less pure form in Jind, Nabha, Patiala, Jaipur, Jodhpur, Loharu, Alwar, Bharatpur and in East Uttar Pradesh.

(4) *Murrah.* The cows of this breed are good milkers and the bullocks are excellent for draught. It is available in Southern Punjab, Delhi and Northern Uttar Pradesh.

(5) *Gir.* The home of this breed is Kathiawar. Pure specimen of this breed is available in Junagarh.

(6) *Kankrej.* The home of this breed is the country to the south east of the Rann of Kutch, extending from the south-west corner of the Tharparkar district in Sind to Dholka in Ahmedabad district, also along the Banas and Saraswati rivers. It is one of the heaviest of Indian cattle.

(7) *Tharparkar.* Coming originally from the arid semi-desert tracts of South east Sind, this breed is mostly bred in India today to the north-east portion of Maharashtra State as well as Marwar (now in Rajasthan).

(8) *Kangayam.* The name of this breed is derived from the Kangayam division of Coimbatore district where it has been in existence for a long time.

(9) *Ongola.* The home of this breed is Ongola tract of Andhra comprising Ongole, Guntur, Narasaraopet parts of Bapatla etc.

It is a significant fact that good cattle are generally found in dry areas and inferior cattle in areas of heavy rainfall. The rainfall map of India more or less coincides with her cattle map.

Thus Punjab, Rajasthan, Gujarat, Mysore and drier parts of Maharashtra and Madras are homes of some of the best cattle in India, while non-descripts (animals possess very poor milking capacity) are found in areas of heavy rainfall, like Assam, Bengal, Orissa and Malabar Coast, now in Kerala).

Livestock Development

Livestock development is stepped up through special schemes such as Key villages, Gosadan, Gaushala development Scheme.

Key Village Scheme

Key Village Scheme was introduced during the 1st Five Year Plan to increase milk production and raise the productivity capacity of cattle. By the end of 1955-56, 146 artificial insemination centres and 553 key village units had been established. During 1964-65, 32 new key village blocks were established, 15 existing blocks, two central semen collection stations and two marketing cells were set up.

Calf Rearing Scheme

Under this scheme selected calves of 6 months age and above are purchased from the cattle breeders and distributed free of cost to the cattle breeders, cooperative organizations etc. During the period April 1965, January 1966, 1080 calves were lifted from Haringhata and Aarey milk colonies.

Gaushala Development Scheme

There are a number of Gaushalas in the country and through this scheme it is proposed to make use of these Gaushalas as cattle breeders and milk producing centres. During the Third Plan period 168 Gaushala will be taken up for development and in 1961-62 the number of gaushalas taken up were 22 only.

Gosadan Scheme

This scheme aims at keeping uneconomic and un-productive cattle from areas where active cattle development work is in progress, to a place known as gosadan, usually established in remote forest area. It is proposed to establish collection centres during the Third Plan. Three Gosadans and 25 collection centres were set up during 1961-62.

Stray and wild Cattle catching Scheme

This scheme is under operation in U.P., Punjab, M.P., J. & Kashmir, and Delhi during 1962-63 up to Dec. 31,1962 it is estimated that 19,371 cattle were rounded up. Of these 1,143 productive ones were distributed for breeding purposes and 5,007 unproductive ones sent to Dandakaranya Project for increasing milk production in the area.

Fodder Development Scheme

This scheme aims at the establishment of fodder and pasture demonstrations plots in villages, distribution of fodder seeds and planting materials to the farmers, popularising sullage making, feeding of good breed cattle on balanced ration, improvement of pasture lands and livestock farms and opening of fodder demonstration-cum-training centres. This programme is currently under operation in 11 states and three union territories. During 1964-65, 148 pasture demonstration plots were established, nine farms taken up for pasture improvement and 11 for production of seeds.

Hide Flaying, Curing and Carcass Utilization Scheme

Bakshi-ka-Talab, Lucknow (developed with the assistance from the Netherlands Government and the F. A. O.) imparts training in hide-flaying, tanning and footwear and leather utilization.

Nomadic Cattle Breeders Scheme

This scheme aims at rehabilitating the nomadic cattle breeders in the States of Andhra Pradesh, Rajasthan, U. P., and Gujarat. It is also proposed to provide better breed's bulls and veterinary aids to breeders.

The All India Key Village Scheme initiated during the First Plan, aims at progressive improvement both in the milking and working capacity of India's cattle population. The Scheme has been expanded in the Third Plan and new measures like the establishment of central

semen collection centres, inservice training centres and setting up of marketing cells in the Animal Husbandry Department have been proposed for effective working under the Third Plan. A sum of Rs. 5.19 crores has also been earmarked for this purpose. The various State Governments are on the spur to see that the key village Blocks take up intensive cattle development work and rural dairy extension programmes.

The Key Village Scheme aims at progressive improvement both in the milking and working capacity of India's cattle population. There are about 25 breeds of cows and eight of buffaloes, in addition to a large number of animals which do not conform to any well-defined set of characteristics. It is possible that by proper methods of breeding, animals of the draught category can additionally become good milk-givers and, after all, what the average cultivator needs is a good dual-purpose animal. In the immediate future to improve the milk supply in urban areas cattle colonies and cooperative milk unions have been established. Rural creameries and milk-drying plants in surplus pockets of the country have also been set up.

At every key village attention is paid to the proper feeding of cattle, control of contagious diseases and marketing of the cattle themselves and their produce such as milk and ghee. Government provides these services free of charge at cultivator's door.

There is provision of about Rs. 54 crores in the 3rd Plan for animal husbandry aimed at developing the milk-yielding capacity of well-defined milk breeds by selective breedings and upgrading of non-descript cattle and improvement of draught breeds in milk without impairing the quality of the bullocks. The above aims are to be achieved through key village scheme, Gaushala development scheme etc.

Dairying

Like Agriculture dairying is one of the major industries in India as milk and milk products contribute not less than Rs. 6,200 million to the national income.

The dairy industry is still unorganized. At present there are 30 dairy plants including new ones installed at Calcutta, Madras, Hissar and Srinagar. Besides 13 new dairies are also taking shape at different places. Pilot milk schemes have been introduced in a number of cities. It is estimated that about 8.5 lakh litres of milk are being handled daily.

The Amritsar dairy project commissioned in December 1962, for marketing of 20,000 litres of milk daily and manufacturing 1,500 tons of spray dried skim milk every year. Similar factories are also being set up at Aligarh, Barauni, Junagadh and Rajkot. The cattle feed compounding factory at Anand set up in 1964-65, produced about 100 tonnes of mixed feed a day.

Important Dairies

Delhi Milk Scheme. Started in 1960 at a cost of Rs. 45 million to the centre and Rs. 150 million to Newzealand Govt. distributed

1,800 mds. of milk daily through 320 depots meeting a quarter of the demand for Delhi city.The dairy gets milk from places within a radius of 80 kilometres (in Delhi, Punjab and U. P.) in the rural areas. The dairy plant is capable of handling 12,000 mds. daily.

Calcutta Milk Project. About 5000 milch animals were removed from the city to Haringhatta Milk Colony and over 13,000 mds. of milk are now handled daily. Toned milk and flavoured vitaminised milk are also supplied.

The following dairy schemes are in operation in the respective States—

(1) Gujarat—Anand Dairy; Kaira Cooperative Milk Union, Junagadh Milk Scheme.
(2) Delhi—Delhi Milk Supply Scheme.
(3) Kerala—Kodapannakunnu and Ollukara Dairy Farms Expansion.
(4) Madras—Madras Cooperative Milk Supply Union.
(5) Maharashtra—Bombay Milk Supply Scheme (Aarey); Poona Milk Scheme; Nagpur Milk Scheme.
(6) Mysore—Kudige Milk Scheme; Bangalore Milk Scheme.
(7) U. P.—Allahabad Cooperative Milk Supply Union.
(8) West Bengal—Calcutta Milk Project; Haringhatta Milk Scheme.

Sheep

Another cattle wealth of India is sheep and goats. Their distribution is widely divergent mainly dependent upon the climatic conditions-the number being smaller in heavy rainfall areas and greater in light rainfall areas. There are about 38 million sheep in the country some of which are mutton variety and some of the woolly type. The annual clip of wool is about 38 million lbs. valued about Rs. 9 crores. The wool which is one of the main products of the sheep breeding industry, holds eighth position amongst the agricultural commodities in the country's export trade and earns 54 million rupees in foreign exchange. The sheep do not only provide wool, but also mutton, mannure, pelts, hair, milk, butter and serve as pack animals to carry essential food grains from their owners, across the precipitous hills where other systems of transport would perhaps fail.

There are about 14 breeds of sheep in India, which can be divided into two distinct types, namely, woolly and hairy. The woolly types produce wool fibres of fine or coarse quality, while the other just produce hair and are reared for manurial purposes, and to provide mutton.

The wool-producing states are the Punjab, Uttar Pradesh, Rajasthan. The average production of wool per sheep in India is 1.9 lb. There is a wool analysis Laboratory in Poona, for the research of wool fibre and various other improvements. The annual production of wool of Indian sheep is very poor when compared to those of other countries. The wool produced in India is also of much inferior quality. As an exception, the Kashmir goats are famous for fineness of their wool. There are some good sheep in parts of India like the Bikaner rams which are of woolly type.

The Carpet Wool produced in India is classified in the World markets as East Indian type of wool and is sold under well-known names of Joria and Bikaneri. The Bikaneri breed hailing from the desert of Bikaner is the hardiest breed known in India. This breed is becoming a cosmopolitan breed of India and is being introduced in different states. The fact that India is one of the main producers of carpet wool, need not give an erroneous impression that India produces only this wool. This country also produces large quantities of fine wool, specially in the hills of the Punjab, Uttar Pradesh and Kashmir. But this does not meet the requirements of our country, with the result, that we have to import about 9 million lbs. of fine wool every year. There are several types of hill-sheep along the Himalayan ranges which produce fine wool, such as Gurez, Karneh, Bhadasweb, and Ramput Busher. The story of Indian hill sheep will remain incomplete without the mention of Pashmina goat coming from Ladakh, Kashmir. This goat produces the finest wool in the world, known as Pasham. We have also Tibetan sheep coming to Indian hills in summer. In the Himalayan regions and in the western portions of the Deccan plateau, breeding the imported Merino with the local sheep, has shown great promise.

Goats

Goats form an integral part of the Indian agricultural economy. The goat is the principal source of meat supply; it also provides manure, skin, hair (Mohair) and milk. There are about 57 million goats in India, which is a fourth of the world's goat population. About a fifth of this is used for milk production. Annually about 17 million goats are in demand for human consumption. About 21.3 million pieces of goat, skins and hides valued at Rs. 75 million are produced in India, of which skins worth about 57.2 million rupees are exported.

The important breeds of Indian goats fall under four broad groups (1) Himalayan goats are found in the hills of Kashmir, Punjab and U.P. (2) There is also the Pashmina goat of Kashmir which produces an undercoat of very fine variety of hair which goes into the manufacture of Shawls. (3) The plain goats comprise some of the

best mutton and milch animals. Some of the better known breeds are Marwari, Konor and Jamnapari. (4) Deccan plateau goats yield small quantities of milk and are mostly reared for mutton.

Rajasthan has the largest goat population followed by Bihar, U. P., Maharashtra and Gujarat.

Pigs

Piggery development has played an important role in solving the food problem of various thickly populated countries including China. Pigs are efficient convertors of meal and food refuse into meat. They are prolific breeders and can give reasonably big returns. The pork flesh provides at a low cost a very rich source of animal protein for human consumption.

There are 4.9 million pigs in India contributing 325 million lb. of pork and 9.48 million lb. of bristle annually valued at Rs. 243.75 and Rs. 5.71 million, respectively. Out of an annual meat production of 1,016 million lb., 325 million lb. alone comes from the pig meat which comes next to goat and sheep meat.

Taking into account the importance of pigs as very economical meat-producers, a comprehensive scheme for the development of pigs and pork industry was included in the latter half of the Second Five Year Plan period. The scheme envisaged the establishment of two Regional Pig Breeding Stations-cum-Bacon Factories, ten Pig breeding units and fifty-one Piggery Development Blocks. As against that, two Regional Stations-cum-Bacon Factories, 15 pig Breeding units and 31 Piggery Development Blocks had been established throughout the country.

Poultry

The poultry industry in India has been so far a village or cottage industry with no support from commercial hatcheries, feed industry or organized or supervised marketing of poultry products. New factors contributing to the development of poultry industry in this country are :

"The demand for poultry and eggs is increasing enormously due to general improvement in the economic level of people and greater appreciation of nutrition in general and food value of poultry products in particular, as eggs and poultry meat are one of the richest sources of animal protein."

"Prices of poultry and poultry products are attractive for the producers".

"Production of other meat (mutton) is not keeping pace with the rising demand. It is poultry, which can be produced on a large scale in a relatively much shorter time and at comparatively less cost, that will try to meet the ever increasing demand of meat".

In order to give incentive to commercial poultry farmers the government has established 17 intensive poultry development blocks and 45 feed manufacturing units. Besides 12 new centres have also been set up for collecting, grading and distribution of eggs. At Gurgaon (Punjab) a big commercial firm has started supplying high quality breeding stock with foreign collaboration. It is proposed to set up similar farms at various other places in different states.

QUESTIONS

1. Analyse the conditions favouring the large number of cattle in India.

2. Write an essay on the cattle problem of India.

3. Describe the importance of cattle in National Economy of India.

4. Discuss fully the present position and future possibilities of developing the dairy industry in India. To what extent would this development help to solve the food problem of the country ?

CHAPTER 7

Fisheries

India, with a coastline of 5635 miles or 9016.0 kilometres, into which numerous large perennial rivers discharge their silt-laden waters, innumerable gulfs, creeks, bays and oceanic Islands, has a fishable area of about 283800 square kms. Similarly, the extensive backwaters, estuaries, lagoons and swamps, numerous rivers, streams and channels and a very large number of perennial and semi-perennial lakes, beels, reservoirs, tanks, ponds and other stretches of water, a large proportion of which is culturable, are a rich potential of inland fisheries. So far as sea area is concerned only a small portion is at present worked. This, it is stated, is because the methods used by Indian fishermen are not modern, most of them using country boats like catamarans and small nets which are not adequate for fishing in deep seas. The chief sources of supply of fish are the coastal margins of the sea, river estuaries and backwaters for marine and estuarine fish and rivers, canals, tanks, inundated tracts, etc., for fresh water fish.

(1) *Inland Fisheries* constitute fresh fish from rivers, canals, tanks, ponds, irrigation channels, inundated tracts, etc. They are the mainstay of inland fisheries of India. The extensive areas of Ganges system, Brahmaputra, Mahanadi, Narmada, Godavari, Krishna and Cauvery are the main areas for inland fisheries. In this class of fish West Bengal leads the rest of India. The three states namely West Bengal, Bihar and Assam account for 72 per cent of the total fresh water fish in India.

Inland fishes are grouped under cat-fishes, mullets, carps, prawns, murrels, feather backs, eels, herrings and anchovies. Though several kinds of edible fish are obtained from fresh water sources, only a fraction of the inland water area is devoted to planned pisciculture.

Regarding fresh water fishes, carps form the most highly esteemed variety, constituting about 34% such as *Rohu*, Catla, Mrigal and Calbaus which are well known throughout India. Other important varieties are cat fish, wallgo, bargarious, clarius, silundia, and macrones belonging to this class. Trout has been introduced into the hill streams in Kashmir, Kumaon and Nilgiri Hills.

Efforts are made to import quick growing varieties of baby fish in the state such as catla (Catla Catla), Rohu (Labeo rohita) and mrigal (Cirrhina mrigala) from West Bengal, for their release in perennial waters in the State in large numbers every year. Large irrigation reservoirs also are being stocked with these varieties so that they may thrive and breed these in course of time. In 1960-61, 62,17,750 carp fly imported from West Bengal were released in different sheets of water.

(2) *Estuarine and Backwater Fishing.* Chilka lake in Orissa, backwaters in Madras, Cochin and Travancore, deltaic areas of Sundarbans and Mahanadi are the principal sources of estuarine and backwater fish. The estuaries of Mahanadi and the Ganga stretching from Puri to Hooghly are extensive fishing grounds containing Hilsa, pomfrets, prawns, catla, cat fish, rohu, etc.

(3) *Sea Fishing.* Sea fishing is mainly carried on in small craft having a displacement of under five tons, in coastal water from five to seven kilometres from the shore and within a depth of 10 fathoms. With the exception of a few offshore fishing boats operating in certain localities, very few fishermen make voyages which would entail staying in the open sea longer than 12 hours at a time. There is, at present, practically no night fishing. This is largely because the equipment used for sea fishing consists mostly of boats, canoes, catamarans and of small nets and tackles which are not a type which can stand the rigours and requirements of offshore or deep-sea fishing. These fishing people, poor as they are, have acute problem of procuring nets, timber for boats sailing cloth, fish hooks and coal tar, etc. So the mechanisation of fishing operation has become an absolute necessity. There are at present 4000 mechanised boats.

The principal sea fish around the coasts of India are herrings, the mackerel, prawns, Jewfish, cat fish, mullets, pomfrets and Indian Salmon Mackerel accounts for over one-third of the total catch. Herrings. account for over 15 per cent of the total catch. Prawns account for 9 per cent of the total catch.

At present sea fishing is carried on within 10 fathoms in the sea, and is confined to the coastal waters from the shore of Gujarat, Canara, Malabar Coast, Gulf of Manar, Madras Coast and Coromondal coast.

Chief Fishing States

Andhra Pradesh with a coast line of 960 kilometres in the Bay of Bengal and with 799,000 acres in Inland waters is very rich in its fishery resources.

The total quantity of fish landed from inland water sources during 1959 is about 80,000 tons as detailed below :

Carps 20,000; Murrel 19,200; Catfish 12,000; Barbus 12,000; Prawns 5,600; Miscellaneous 10,400. There are 13 fish farms at Ippur, Mopad, Sunkesula, Patha, Cuaddapah, Hussain-Sagar, Rajendra Nagar, Dindi, Manair, Koilsagar, Nizamabad, Shanigram, Wyra and Warangal.

Kerala State, the smallest maritime state in India with just over 474 kilometres of sea coast, contributes to a little over 25 per cent of the total seafish landed in India. Oil Sardine (Sardinella longiceps) and the Chub mackerel (Rastrelliger Canagurta), the two most important Shoaling fishers of the west coast contribute to the major fishery of the coast, the third important constituent being prawns.

The estimated landing of all fish in the State is about 290,000 tons of which 50,000 tons are contributed by inland water fishes the rest being sea fishes. This quantity is valued at about Rs. 5,50,00,000. 70% of the population in Kerala is fish eaters.

Gujarat has a coast line of over 1649 kilometres extending from Lakhpat in the north of Umbergaon in the south. It has a total fishable area of 25,000 sq. miles including the Gulf of Kutch and Gulf of Cambay.

Maharashtra. Maharashtra State has a sea board of more than 720 kilometres extending from Redi (District Ratnagiri) in the south to Zai (District Thana) in the north. The inland fisheries extend to Bhandara District in the East, a crowflight distance of over 800 kilometres. The most important varieties of sea fish caught along the coastline : Saranga (white Pomfret); Halwa (Black Pomfret); Ghol (Jew fish); (Giant Threadfin); Ravas Indian Salmon); Kuppa (Tuna); Surmai (Seer fish); Boi (Mullet); Mushi (Sharks); Wam (Eels) etc.

Mysore. Mysore state has 320 kilometres of coast line on the Arabian sea. All along this sea board, there are many fishing villages, the most important of them being Karwar, Ankola, Kumta, Honnawar, Malpe, Udiyawar etc. The total fish production on Mysore Coast is one-seventh of the total marine fish landing in India.

West Bengal is one of the most important fishing centres in India. The total value of the sea fish caught in 1958-59 was Rs. 1,26,236.33.

The total landing of marine fish by State is shown in table XXVII below. (where available).

TABLE XXVII—*The total landing of marine fish by State*

State	in metric tons 1963	1964
Bengal and Orissa	11,176	10,642
Andhra Pradesh	64,193	71,727
Madras (Including Pondicherry)	109,602	1,31,309

Kerala	203,242	3,17,974
Mysore	39,176	1,04,218
Maharashtra	1,24,587	1,30,603
Gujarat	1, 2,040	92,882
Goa	—	643
Andaman (South)	159	148
Minicoy & Laccadive Islands	589	1.90
Trawlers	—	—
Total	6,55,484	8,60,336

Varieties of Fishes. More than 1800 distinct species of fish are known to exist in the seas around the country and inland waters, but the varieties that are caught in appreciable quantities are limited in number. Pisciculture experts classify the commercially important varieties of sea fish into 15 groups and freshwater fish into eight.

The sea fish groups include elasmobranchs, eels, cat fish, silver bar fish, herrings, and anchovies, Bombay duck, mackerels and perches, silver bellies, flat fish, mullets, Indian Salmon which is stated to be not a true Salmon, jew fish crustaceans and minor shell-fishes.

Regarding river fishes, the following may be specially mentioned—mahseer available in the upper reaches of most rivers in India. Chilwa is a flat-sided, thin bodied fish with his stomach running an edge. It occurs freely both in the north as well as in south Indian rivers. Murrel varies from 2 to 3 ft. in length. Batchwa is small but excellent for eating. Barils has 14 species and they are widely distributed throughout India. Olive Carp is available in Madras and is also found in the fresh waters all along the coast of India from Kutch to Bengal. The following is a list of the names of fishes showing their production in metric tons in 1963 and 1964 respectively.

TABLE XXVIII : *Production of Various Kinds of fish in India.*
(in metric tons)

Fish	1963	1964
Elasmobranchs	42,977	34,863
Eels	8,685	2,255
Cat fish	17,567	22,730
Chirocentrus	7,645	7,565
Oil Sardine	63,647	2,74,409
Other Sardine	27,173	40,318

Hilsa Ilisha	2,754	3,441
Other Hilsa	5,312	6,519
Anchoveilla	28,672	25,199
Thrissocles	5,704	6,619
Other Clupeids	14,485	16,752
Harpodon Nepereus	9,1870	8,1342
Saurus	660	1,545
Hemihamphus and Belone	3,443	1,527
Flying fish	962	920
Perches	8,597	12,559
Red Mullets	2,395	5,027
Polynemids	4,389	2,155
Sciaenies	22,570	25,198
Ribbon fish	16,452	25,897
Caranx	17,513	26,930
Chorinemus	3,195	2,448
Coryphaena and Elacate	195	345
Trachinotus	14	115
Leiognathus	17,748	28,301
Gazza	85	35
Lactarius	8,654	6,508
Pomfrets	17,256	19,583
Mackerel	76,980	23,975
Seer fish	9,116	11,165
Sphyraena	1,258	1,663
Mugil	1,505	2,913
Bregmaceros	5,407	3,721
Soles	8,381	6,146
Penaccid Prawns	41,071	63,441
Non Penaccid Prawns	40,522	31,506
Other Crustaceans	2,061	4,565
Cephalopods	260	463
Miscellaneous	23,408	24,445
Total Marine	6,55,484	8,60,363
Total Inland	390,425	4,55,273
Grand Total	104,5909	13,15,609

Fish being a highly perishable commodity, adequate facilities for marketing are absolutely essential. Ice-cold storage, processing and canning are necessary processes for securing a reasonable price for the catches. A beginning has already been made in the second Plan. Freezing facilities for prawns have come up in Cochin, Mangalore and Bombay. During the third Plan period it is proposed to have 72 cold storage plants distributed in different states to facilitate movement of fish in good condition to consuming centres. In addition, freezing and canning units are expected to be established in Coastal districts in Western India, specially in Kerala, Mysore and Gujarat.

Another important item for the improvement for fish production in India is the refrigeration without which this problem cannot be solved. At present, though large quantities of fish are being caught, but for want of refrigeration facilities and transport, only a small portion of the catch can be used in a fresh condition. So for the better supply of fishes, two things are absolutely necessary (1) quick transport of fresh fish from large assembly centres to some of the towns in fast motor vans, (2) provision of refrigerated rail transport. For the freezing and cold storage, erection of cold storage plants are the ideal solution for the proper preservation of fish and also erection of as many ice factories as possible, so that adequate quentities of ice may be available at all important fishing and consuming centres.

Fishing Industry. India produces about 0.89 million tons to marine fish out of the total fish production of 1.3 million tons, which is only a quarter of the country's requirements, estimated at about 4 million tons annually. The average catch is about 2500 lbs. per man per year. Production is shown in table XXIX below. About two-thirds of the catch are marine fishes.

TABLE XXIX : *Production of fishes.*

(in'000 tonnes)

Year	Marine	Inland	Total
1957	875	358	1,233
1958	755	309	1,064
1959	585	239	823
1960	878	282	1,160
1961	684	277	961
1962	644	330	974
1963	655	390	1,046
1964	860	455	1,315

The fishing industry in India offers employment to about a million persons and contributes annually over Rs. 60 crores towards national income.

There is practically no fish-canning industry in India but curing is being carried on in various ways. In India fish is preserved by desiccation with or without salt and by the use of antiseptic preservatives, such as brine, vinegar, etc. The main process is the desiccation by drying fish in the sun. It is also done by salt. Canning is practised on a limited scale in Madras and Bombay. The cured fish has developed lucrative export trade with Ceylon and other countries. Fish curing yards have been established along the coasts of India. In order to develop fish industry in India on an extensive scale refrigeration system has become absolutely necessary. Cold storage facilities are being developed in every part of the Country.

Fisheries in India, though very under-developed, contribute annually about 60 crores to the national income. Rich in proteins, vitamins and mineral salts, fish is a valuable protective food. It forms an important constituent of the diet over considerable areas.

Besides articles of food, fish yields several by-products, such as fish oil, fish-meal, fish manure, fish maws and shark fins. The most important is fish oil, such as, cardine oil and shark-lever oil which are now produced on commercial basis in India. The oil is used for the manufacture of paints, soft-soaps, for softening hides, for tempering steel, batching jute and after hydrogenation for the preparation of edible fats. Fish liver oil produces Vitamins A and B indispensable for wasting diseases. It is being manufactured by the Governments of Bombay, Madras and Travancore. The Government shark-liver oil factory is situated at Kozhikode, Madras, which supplies shark lever oil for use in hospitals and for sale to the public. Indian fishes such as Salmons, Jew fishes, Cat-fish are yielding sing-glass, a valuable article for the clarification of wines. Bombay, east coast of Madras and Sundarbans in Bengal are the centres of trade of this commodity. Fish-scraps are converted into fish meal as additional protein food for poultry and livestock. Fish refuse is being dried as fish manure. Fish-curing is also an important supplementary trade. The chief methods of curing fish in India are sun-drying and salt curing, either by dry or wet process. The production of fish during 1964 was 13.2 lakh tonnes as against 10.5 lakh tonnes in 1963. The following table xxx shows the production and disposal of fish in 1961, 1962 and 1963.

TABLE XXX : *Production and Disposal of fish*

(*in thousand tonnes*)

Year	Total catch & landings	Disposal: Fresh Marketing	Cured: Sundried	Cured: Salted	Reduction
1961	944	453	219	194	79
1962	958	459	222	197	80
1963	1,046	705	151	138	52

The value of exports of fish and fish products reached a record level of Rs. 6.53 crores in 1964.

Rate of Consumption. At the present level of production the availability of fish for the country as a whole works out at 3.4 lbs. per annum per capita as against 16 lbs. in Ceylon, 70 lbs. in Burma, 90 lbs. in Japan, and 40 lbs. in U.S.A. A considerable section of the population of India does not, however, eat fish. Allowing for this, the average per capita consumption is estimated at 4.9 lbs. The per capita consumption of fish varies considerably from state to state. The following table XXXI shows the per capita consumption in various states of India.

TABLE XXXI : *Per Capita Consumption of fish in Indian States*

Kerala	21.00 lbs.
Madras	12.70 lbs.
Bengal	6.73 lbs.
Assam	3.40 lbs.
Bihar	2.00 lbs.
Punjab	0.09 lbs.

Consumption is lowest in the Punjab (0.09 lbs.). The requirements of a balanced diet are estimated at 1.3 ounces per day per adult *i.e.*, 30 lbs. per capita per annum of fish and/or meat. The availability of meat is poorer still.

In the FAO surveys India has been included in the category of low fish-consuming countries whose average per capita consumption falls below five kilograms. India's neighbour, Burma, is among the fish consuming countries with an average of 20 kilograms per capita.

Approximately 92% of the total production in India is used for edible purposes and eight per cent for the manufacture of industrial and other products.

Total catch of fish amounted to 12 lakh tons in 1957 which declined during 1961 by 2.5 lakh tons. This fall in production was mainly due to failure in sardine and mackerel fisheries. During 1961-62 approximately 15,457 tons of fish valued at Rs. 3.91 crores were exported and at the same time 20.346 tons of fish and fish products were imported at a cost of Rs. 3.87 crores.

Mechanized Fishing. Experiments in mechanization of fishing are being conducted since 1948 with the help and assistance received from Norway, U.S.A., and F.A.O. The F.A.O., T.C.M. and Indo-Norwegian Foundation continued to give valuable technical assistance. Many harbour specialists continued work in connection with the development of fishing harbours in the States of Maharashtra, Kerala, Madras,

Mysore, and Bengal under the Expanded Technical Assistance Programme of F.A.O. Many fisheries engineers worked on the Madras, Kerala, Gujarat and Maharashtra Coasts, on the introduction of new types of fishing gear, use of mechanized aids and the training of fishermen in their use. Under the Indo-Norwegian Project 1600 boats of improved types were built and mechanized upto 1964-65. Contracts have been entered into for the import of 1,137 marine diesel engines; in addition 710 indigenous engines are expected to be made available.

To train persons in fishing trade and development the government has established central Inland Fisheries Research Institute at Barrackpore. For sea fishing there is another centre at Mandapam Camp known as Central Marine Fisheries Research Institute. Besides, there are other stations which conduct exploratory surveys for charting new fishing grounds. These are at Bombay, Cochin, Tuticorin, Visakhapattam and Mangalore. To evolve efficient mechanical devices two new stations have been set up at Cochin and Ernakulam. The Central Institute of Fisheries Education at Bombay imparts training in advanced fishing technology. Apart from that 10 new extension units and 14 fisheries are working at various places. The State fisheries department and field staff of Community Development are also laying greater emphasis on trained personnel and efficient methods of fishing. During the Third Plan schemes have been formulated to boost production and quick disposal of fish and fish production. Measures have also been adopted to export a fair quantity of dried fish and fish product. The main objective of fishery programme in the Third Plan is increased production so that adequate animal protein diet becomes available to the population and also sufficient fish for export trade.

QUESTIONS

1. Discuss the fishing industry of India, with reference to (a) the Main fishing grounds and (b) the location of fishing ports and trade.

2. Give a concise account of the various types of fisheries of India, with special reference to their present position. Give a reasoned account of the steps that should be taken to preserve the chief fishing grounds.

3. Discuss fully the present position and the future possibilities of developing the fishing industry in India. To what extent would the development help in solving the food problem of the country ? (*Agra*, 1954.).

4. Discuss fully the fishery resources of the Indian Republic and their exploitation, laying emphasis on future development. (*Agra*, 1956).

CHAPTER 8

Irrigation

The greatest development in the history of mankind was the discovery of agriculture and then came irrigation. Irrigation has been practised from very ancient times in our country. Mention of irrigation works is made in the Vedas, Puranas and other epics.

Agriculture being the main occupation of about 75% of the population of the country, irrigation assumes paramount importance lest the vagaries of nature and uncertain rainfall lead to ruining of crops resulting in famine conditions. Irrigation serves a dual purpose in our agricultural economy—firstly, they provide protection to crops against destruction and damage by failure of rain and secondly, they increase the yield of crops even in normal years.

In our country, whose economy is predominantly agriculture, the need of artificial watering of crops has always been felt, because the rainfall it gets is neither evenly distributed, nor is it regular or certain.

Irrigation is one of the methods whereby Indian agriculture is assured of stability. There are two features in Indian rainfall which make irrigation necessary. These are : (a) Uncertainty of rainfall distribution, both in time and place. The outstanding feature of the rainfall in India is its unequal distribution during the year and its variation from year to year in respect of quantity, incidence and duration. The average annual rainfall in India is 127 cms. but it is only of the order of 12 cms., in the desert in the north-west, increasing gradually across the plains of northern India from west to east until it is about 254 cms. in Assam. In central parts of India, the mean rainfall is of the order of 127 cms. a year, and in the Peninsula, except along the west coast, the mean annual rainfall is of 76 cms. Almost the entire rainfall in the country is due to the south-west monsoon and is received during the four months of June to September, with the exception of the south-east portion of the Peninsula, where the rainfall is heavier from October to December

In winter the rainfall varies from 1 to 5 cms. except in north-east monsoon areas, and from March till the onset of the south-west monsoon, the country is almost rainless. Apart from its unequal distribution in the year, the rainfall shows considerable variations from year to year.

It is not uncommon in many places for rainfall in a year to be less than half the normal. (b) irregularity in distribution through the year, *i.e.*, the concentration of practically the whole of the rain in a few months, leaving the rest of the year dry. Most of it, however, occurs during the four months of June-September, when many rivers are often in spate. On the other hand, about 30 per cent of the area gets less than 76 cms. rainfall a year, necessitating irrigation measures.

Rainfall in the country is as already mentioned unequal and in many areas uncertain. The distribution is as follows—

Range	(in crore hectares)	Percentage
Area between 0.76 cms.	9.5	29.6
Area between 76-127 cms.	13.6	42.0
Area between 127-189 cms.	5.81	17.8
189 cms. and above	3.4	10.6
Total Area	80.63	100.0

Temperatures in India being suitable for the growth of crops throughout the year this shortage and uncertainty of moisture supply is a great hindrance and is partly removed by irrigation.

India occupies the most important place in irrigation in the whole world. Roughly, about one-third of the total irrigated area of the world lies in India. Some of the largest canal systems of the world are found here. All this is because nature has endowed India with certain advantages that are seldom to be met with in other parts of the world on such a large scale.

In spite of it, India is not able to satisfy her entire demand for irrigation. It is only a small fraction of her total cultivated area that gets irrigation. Only about one-fifth of the total cultivated area in India is being irrigated. Of the 142.12 crore hectares of the total cultivated area in India in 1958-59 about 3.12 crore hectares received irrigation, which although is only 16% of the total cultivated area, yet has registered an increase of 3.2 lakh hectares over the total irrigated area in 1950-51.

Of the total area under cultivation, nearly 19 per cent is irrigated. During the period 1950-51 to 1962-63, the net irrigated area increased by 49 lakh hectares.

The poverty of the people and lack of irrigational facilities over certain parts in India are obviously the reasons for this small proportion of irrigated area. Most of the irrigated area in India (about 60%) lies in the Indo-Gangetic Valley where facilities for irrigation are the

greatest. Owing to the fertility of the soil and the cultivation of certain important crops like sugarcane here, it pays to irrigate in this valley.

Irrigation is needed in India :—

(i) for the whole country to grow Winter or 'Rabi' crops during the long dry season, characteristic of monsoon climates;

(ii) for those arid regions in which the normal rainfall is too meagre to allow agriculture without being regularly supplemented by artificial irrigation; the entire agriculture of such regions depends on irrigation, as in some parts of Rajasthan and the Punjab ;

(iii) for those areas in which the rainfall is insufficient and uncertain.

It is only in certain areas like Bengal, Assam, and the Submontane Tarai regions, where the moisture supply is always abundant that irrigation is not needed.

GEOGRAPHICAL ADVANTAGES

The geographical advantages for irrigation in India are :—

(a) the perennial rivers of the north, with the sources in the perpetual snows of the Himalayas;

(b) the gradual slope of the plains, so that the canals taken out from the upper courses of the rivers easily irrigate the land in their lower valley;

(c) the absence of rocky ground in the plains facilitates easy cutting of canals.

(d) the fertile soil which gives the greatest returns to irrigation; and

(e) clay-beds, deep in the sub-soil, which act as reservoirs for the rain water which sinks through the porous alluvium of the plains and which is later tapped by wells.

The following table XXXI shows the total land irrigated by various sources during the year 1962-63.

TABLE XXXI : *Irrigation in India,* 1962-63.

(in thousand hectares)

	Canals	Wells	Tanks	Other Sources
Andhra Pradesh	12688	428.8	1315.2	1324
Assam & NEFA	3596	—	—	2536
Bengal	7688	15.6	3640	1872
Bihar	5094	306.4	285.6	7792

Gujarat	1040	443.6	17.0	360
J. K.	2744	2.0	48.8	76
Kerala	1520	2.0	170.8	1296
M. P.	4580	338.4	928.8	912
Madras	9140	587.2	197.2	436
Maharashtra	2520	624.4	366.4	392
Mysore	2660	153.6	412.4	240
Orissa	2892	23.6	6.8	2032
Punjab	21876	1010.8	119.6	240
Rajasthan	6356	1053.6	434.4	288
U. P.	20840	2430.8	5.2	2720
Delhi	140	16.4	—	—
H. P.	200.0*	200.0*	—	396
Manipur	672	—	—	—
Tripura	—	—	1.2	128
Andaman-Nicobar Islands	—	—	—	—
Laccadive & Amindivi	—	—	—	—

The most important sources of irrigation in India are :—

(i) Canals;

(ii) Wells; and

(iii) Tanks.

The canals are the most important sources of irrigation because of their cheapness and the ease and certainty of supply.

The following table XXXII shows the area under irrigation during the year 1950-51 and 1962-63 and the table also shows that during ten years the net area irrigated increased by 49 lakh hectares.

TABLE XXXIII : *Area under Irrigation*

Source	(in crore hectares) 1950-51	1962-63	Increase or decrease
Canals	0.83	1.09	+0.26
Tanks	0.36	0.47	+0.11
Wells	0.60	0.77	+0.17
Other Sources	0.29	0.24	—0.05
Total	2.08	2.57	+0.49

*Below 200 hectares.

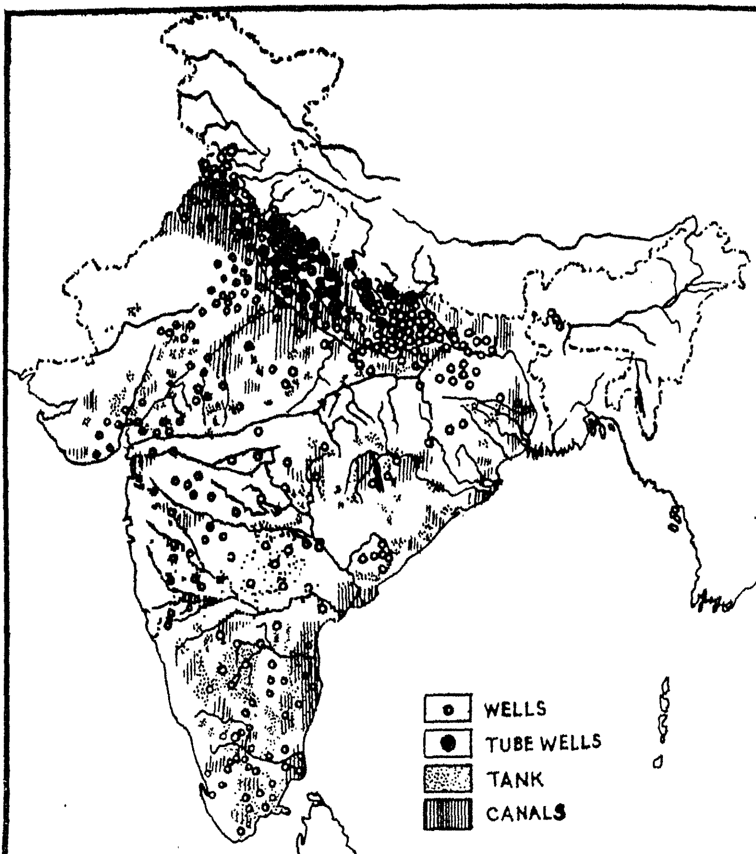


Fig. 21. Important sources of irrigation in India.

Out of about 58 million acres, the total area irrigated in India, about 24 million acres are irrigated by canals (Government and private, both) Figure 21 shows the important sources of irrigation in India.

CANAL IRRIGATION

The canals in India are of two classes :—

(a) Inundation canals; and
(b) Perennial canals.

(a) *Inundation canals* are taken out from rivers without building any kind of weir at their head to regulate the flow of the river and the canal. Whenever the river is in flood, water passes into these canals. As soon as floods subside and rivers fall below the level of the canal heads these canals dry up. The greatest defect of these canals

is that their water supply is very uncertain. They provide irrigation mostly during the rainy season when alone the rivers are mostly in flood. During the dry period when irrigation is needed most, these canals are useless. The larger number of inundation canals is in the Punjab. They have been taken out mostly from the Sutlej river, which has high floods during the rains. Owing to the uncertainty of water supply, most of the inundation canals are being converted into perennial canals with the help of the development of the large irrigation schemes.

The real importance of irrigation in India is that of the Perennial canals, about 8000 kilometres including the mileage of the distribution. This length is so great that it can completely encircle the earth at the Equator twice. Such stupendous irrigation works have never been known in the history of the world before. And yet, they are not enough for the needs of our agriculture.

(b) The *Perennial canals* irrigate only about one-tenth of the total cultivated area of India. The largest mileage as well as the largest acreage irrigated is in U.P. where about one-third of the total cultivated area is irrigated by canals.

IRRIGATION IN THE PUNJAB

There is no part of India which is so favourably situated as regards its rivers, or so unfavourably as regards its rainfall as the Punjab.

By far the greater portion of it has less than 62 cms. of rainfall per year. Even this amount is often liable to failure until the introduction of irrigation, therefore, a large area was a waste. The only exception were the river banks where agriculture was possible to some extent by means of inundation canals and wells.

The problem of irrigation in the Punjab was different from that in other States of India. In all other irrigation schemes the main object had been the improvement of the existing agriculture. In the Punjab, some tracts had to be colonised, simultaneously with the introduction of irrigation.

(1) *The Western Jamuna Canal.* The western Jamuna Canal took off at a distance of about 288 kilometres from Agra, and irrigated the districts of Ambala, Hissar, Karnal etc., of the Punjab. Owing to inattention it ceased to function after some time, but two centuries later its restoration was ordered by Akbar so that it could supply water to his Hansi and Hissar branches. Later, Shahjehan took a branch of the canal (the Delhi branch) to his gardens and fountains. The total length including channels exceeds 3040 kilometre long channels in the districts of Rohtak, Hissar, Patiala and Jind.

(2) *Sirhind Canal.* This canal was completed in 1884. It takes water from the Sutlej river at Rupar. Its main branches are Bhatinda branch, Abohar branch and Kotla branch. The total length of the canal is 6,000 kilometres and irrigates 5,85,000 hectares of land.

(3) *The Upper Bari Doab Canal.* It was completed in 1879 and takes water from Ravi at Madhopur. Its main branches are Lahore and Kasur (now in Pakistan), and Sonkh in India irrigates 3,31,200 hectares of land in Amritsar and Gurdaspur.

(4) *Bhakra Canal.* The Bhakara canal system commands a gross area of about 27.4 lakh hectares, of which the cultivable commanded area is 23.7 lakh hectares. Its main branches are Fatehabad, Samana Nakhana, Pirthala and Tohana. An area of 13.02 lakh hectares in Punjab and Rajasthan received irrigation during 1964-65.

(5) *Nangal Canal.* The main canal is 64 kilometers long. It irrigates 26.4 lakh hectares of land. District-wise distribution of irrigation in Punjab is shown in the following table—

Jullundar District	180000	hectares
Ferozepur	222600	,,
Ludhiana	99960	,,
Karnal	269720	,,
Hissar	729560	,,
Ambala	39600	,,
Total	15,41,440	,,

(6) *The Triple Canals system* in the Punjab is one of the largest in India. Its main object is the irrigation of a tract of the Punjab lying between the Ravi and the Sutlej rivers, bounded on the south by the dry bed of the Beas, known as the lower Bari Doab. This system transfers the waters from the Jhelum, where they were much greater than could be utilised in the watershed between the Jhelum and the Chenab, for irrigating the water-shed between the Chenab and the Ravi and the Lower Bari Doab.

The transfer was effected by constructing a regulator at Mangla on the Jhelum. From Mangla the Upper Jhelum Canal carries the Jhelum into the Chenab, discharging it into the latter above the head-works of the Lower Chenab Canal at Khanki. The Lower Chenab Canal is thus fed with the Jhelum water, and the water of the Chenab so freed is taken from a new head-work situated at Merala, 57.6 kilometres above Khanki, into the Upper Chenab Canal. This canal runs south-wards to the Ravi, which is crossed on the level at Balloki. Below Balloki it is known as the Lower Bari Doab Canal.

The three rivers, Jhelum, Chenab and Ravi are thus inter-connected by means of the Upper Jhelum Canal and Upper Chenab Canal.

The chief reason for this scheme of canals was to conserve the Sutlej water for the further development and extension of irrigation on either side of the river. The Sutlej Valley Scheme was, thus, the direct outcome of the great Triple Canal system. The Triple Canals Scheme has brought a further huge extent of wasteland under cultivation.

There are, on either bank of the Sutlej, long series of inundation canals, which draw their supplies from the river, whenever the river level was high.

The object of the Sutlej Valley Scheme is threefold :—

1. By providing weirs and head regulators, to afford to the existing inundation canals a controlled supply of water from the beginning of April to the middle of October, thus freeing them from seasonal fluctuations. These canals are now converted from inundation to non-perennial canals *i.e.*, the supply is assured during summer as well, though they are closed during winter, when the volume in the river is low.

2. To extend irrigation to all the low-lying areas in the Sutlej Valley.

3. To give year-round irrigation to large tracts in the uplands on either side of the river.

A special feature of the canal system of the Punjab lies in the fact that all the rivers of the Punjab have been interconnected by means of canals so that the water resources of all the rivers are pooled together to give the greatest service. All available supplies of water in the rivers are utilised to the full.

The scheme consisted of four weirs, three on the Sutlej and one on the Panjnad (the name given to the Chenab below its junction with the Sutlej now in Pakistan) with twelve canals taking off from above them. The scheme really consisted of four inter-connected canal systems.

The largest canal system of the Punjab is the Sutlej Valley Canal system which accounts for about one-fourth of the canal-irrigated area of the Punjab, including Pakistan. Weirs have been constructed at four places on the river Sutlej and eleven canals have thus been taken out on both sides of the river. These dams are at Firozpur, Sulemanki, Islam and Panjnad. The most important crops irrigated in the Punjab are wheat and cotton. These two crops account for about half the total irrigated area. Rice comes next in importance.

The canals that are wholly in the Punjab (India) are the Bari Doab canals, the Sutlej Valley canals on the left bank of the Sutlej, and the Sirhind canals starting from Rupar. Fig. 22 shows the canals in the State of undivided Punjab.

The primary importance of the canals in U.P. is that they are essentially meant for periods of drought. Unlike the Punjab where, over large parts, no cultivation is possible without canals, in U.P., in normal years, there is enough of rainfall and there are plenty of wells, so that it does not require canal irrigation. Canals when once built must be used, because irrigation from them is cheap and convenient. The largest canal system in U. P. is that of the two canals from the Ganga; though, if taken singly, the Ganga canals yield the place of honour to the newly constructed Sarda canal. The Upper Ganga canal,

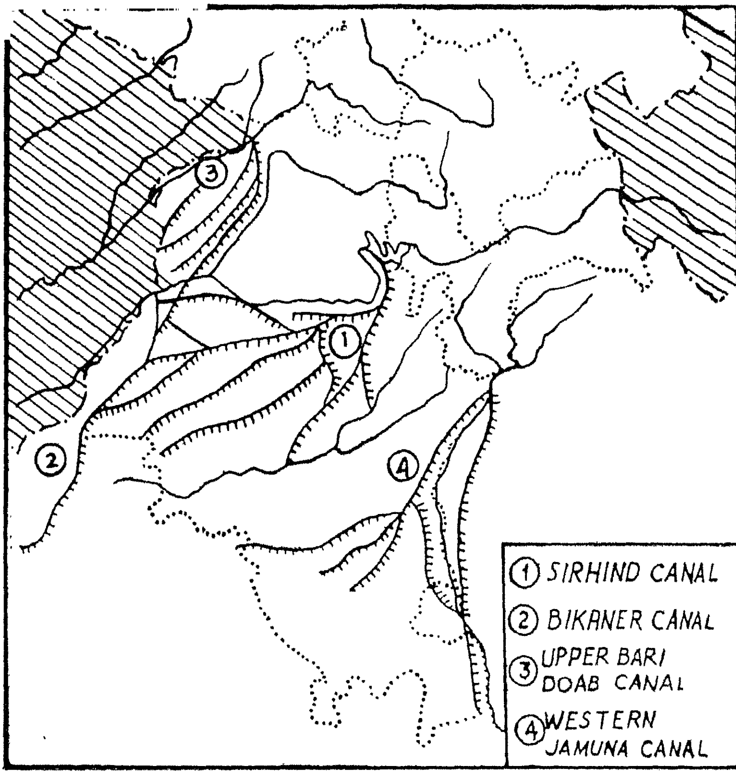


Fig. 22. Canals in the State of Punjab

IRRIGATION IN U. P.

as well as the Sarda canal have been taken out at a point where the rivers come down from the mountains. Owing to the heavy rainfall a large number of rivers rise in the **Terai** and join the Ganga in its middle course, It becomes possible, therefore, to take out a Lower Canal to irrigate the middle section of the valley. Such a thing is not possible in the Punjab where rainfall is less and the **Terai** is absent, leading to the absence of tributaries in the middle course of the rivers. The volume in the Punjab rivers dwindles as they flow away from the mountains, while in the case of U.P. rivers it increases because the rivers flow through a wet country. This enables a 'lower canal' to be taken out. The Lower Ganga canal already exists, while Lower Sarda Canal has recently been constructed as people become used to canal irrigation. There are two canals from the Jamuna also. Few minor canals also exist in south U. P. like the Ken, Ghaghra and the Betwa canals and in the east namely Dohri Ghat Canal.

Canal irrigation is no less important than well irrigation in U.P. The area irrigated by canals here is about 2.0 million hec. This is only

about one-tenth of the total area sown, and only one-third of the total area irrigated. The canal-irrigated area in U.P., however, fluctuates from year to year according to the condition of rainfall. In the years when the rainfall is scanty, canal-irrigated area is very large. The wheat, barley, sugarcane and cotton are the important irrigated crops.

Like the Punjab, a serious problem has arisen in the canal-irrigated areas of U.P. and that is the problem of alkaline soils which are believed to be due to over-irrigation, so natural in a country where scarcity of water leads to famine.

The high rainfall makes it necessary to construct and maintain drainage works in this State to safeguard the canals from damage. The drainage works in this State have a longer mileage than the canals themselves.

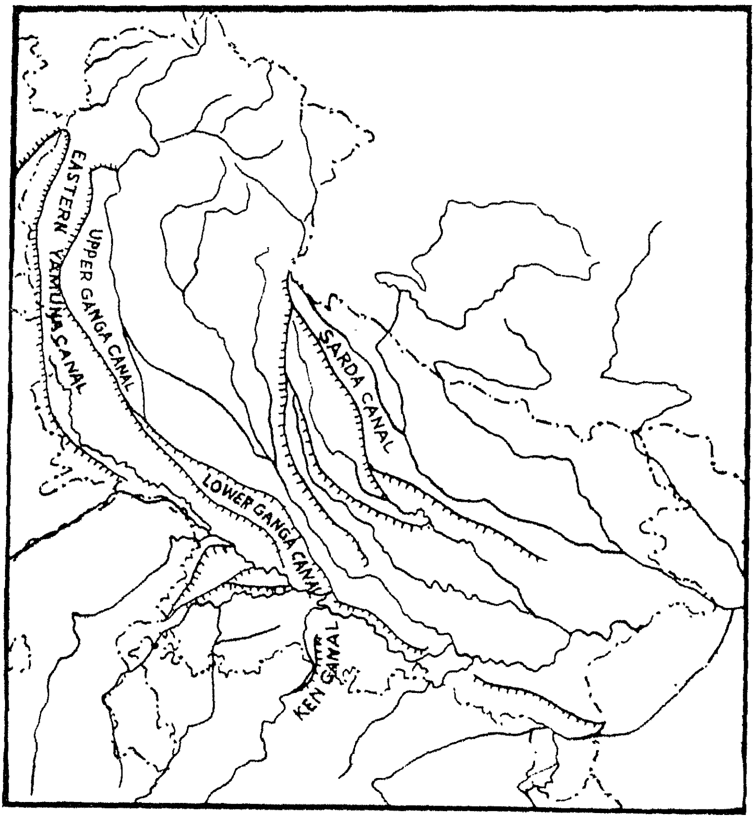


Fig. 23. Canals in U. P.

An important service rendered by the canals in U.P. is that they help in reducing the intensity of floods in the Ganga and the Jamuna, by opening up all their branches and distributories in flood time.

(1) *The Upper Ganga Canal* was completed in 1854. It takes off from the Ganga at Hardwar and passes through a broken country, passing over or under bridges. Its main branches are Deoband branch, Anupshahr branch, Mat branch and Hathras branch. The Upper Ganga Canal is the oldest canal built by British engineers. As the slope of the ground was not properly surveyed at the time of the cutting of the canal, the flow of the water was defective. To remove this defect artificial waterfalls were made in this canal at several places. The main canal joins the Ganga river at Kanpur, but one of its branches continues beyond Kanpur and ultimately joins the Jamuna above Allahabad. The main canal is 213 miles (242 kms.) long with branches and distributories totalling 3,400 miles (5474 kms.). It irrigates 48,80,000 hectares of land.

(2) *The Lower Ganga Canal.* It was in 1854 that the Ganga Canal was opened and Col. Sir Proby Cautley's efforts bore fruit. The canal system as originally designed provided irrigation up to Kanpur and Fatehpur districts, but soon it was felt that the canal headworks at Hardwar were insufficient to feed all the length of the channels. Leakage of some river water down the headworks was inevitable and a considerable amount of inflow into the river below Hardwar could also be harnessed if another headworks were constructed at Narora. So the Narora Headworks took shape in 1877 and the original system divided into the Upper Ganga Canal and the Lower Ganga Canal.

The Lower Ganga Canal was extended during the course of years and today the system has over 8,800 kilometres of channels which command a total culturable area of 11.2 lakh hectares in the Bulandshahr, Aligarh, Etah, Farrukhabad, Mainpuri, Etawah, Kanpur, Fatehpur and Allahabad Districts of Uttar Pradesh. The channels irrigate 5.2 lakh hectares annually of which 3.6 lakh hectares are irrigated in the *rabi* crop and 2.0 lakh hectares in the kharif crop. New *usar* land in Etawah district is being broken every year and there are proposals to command new kharif areas and increase the annual irrigation further by construction of new kharif channels.

(3) *Eastern Yamuna or Jamuna Canal.* Just opposite the western Jamuna Canal another artificial stream of water was taken out of the Jamuna from its left bank during the Moghul period. It is not known with any great accuracy during which particular region this channel, which today in its modified form irrigates Saharanpur, Muzaffarnagar and Meerut districts and finally terminates on the left bank of the river opposite Delhi, was constructed, but it is fairly certain that it was projected either by Shahjehan (1628-1659) or by Mohammed Shah (1748-49) and that its was originally known as the Doab Canal.

During British rule the remnants of the old channel suggested its reconstruction again. The canal was first designed to pass a discharge of 800 cusecs. The capacity was increased to 1,400 casecs and thereafter to 1,780 cusecs for *rabi* season and 2,260 causecs for kharif season.

The districts of Saharanpur, Muzaffarnagar and Meerut have prospered for centuries through the benefit of irrigation from the Eastern Yamuna canal.

(4) *The Agra Canal.* The third canal which takes off from the river Yamuna, is the Agra Canal, opened on March 5, 1874 by Sir William Muir, Lt. Governor of the then Western Provinces.

The canal was originally constructed to carry 1,100 cusecs during the *rabi* and 2,000 cusecs during *kharif* but it was later found that the available supply in river Yamuna fell short of expectations. The supplies were supplemented by constructing a dam across the river Hindan which is below the railway bridges between Delhi and Ghaziabad and a cut to connect Hindan and the Yamuna above Okhla. Further experience showed that even the combined supplies of Hindan and Yamuna did not suffice to feed the canal in time of demand. To make up the shortage supplies of the Hindan river were supplemented by the discharge escaped at Jani from the Ganga Canal.

The tract commanded by the Agra Canal is bounded on the north and east by river. Yamuna, on the south by Utangan river and on the west by ranges of the Arawalli Hills. The area commanded by it is 558880 hectares.

The Sarda anal is the longest anal in U. P. It was completed in 1930. It is taken off from the Sarda river near Baramdeo near Nainital. One of its branches feeds the Rohilkhand Canal. The other branches irrigate the area of ihc Ganga-Ghagra Doab. It irrigates nearly 5,20,000 hectares of land.

(A). *Sarda Sagar Stage* I. To meet the irrigation demand of the eastern districts of Uttar Pradesh, the State Irrigation Department had for years been anxiously exploring all the possible methods of augmenting the supplies in the 10,000 cusecs Sarda canal during the winters when the river discharge falls down to about 5,000 cusecs or even less sometimes. Two Storage Schemes were conceived *viz.*, Surai Sagar and Mala Sagar, on the right bank of the Canal in its head reaches.

(6) *Govind Sagar.* This is an earthen dam, 18 metres high and 3384 metres long, constructed across the Shahzad River near Lalitpur town in Jhansi district to irrigate an area of 17,200 hectares of land.

(7) *Banganga Canal.* About 4.8 kilometers from Shohratgarh Railway station on Gonda-Gorakhpur loopline, a barrage, having 16 sluice gates has been constructed across the Banganga River to divert part of the river's water into a network of two canal systems, 144 kilo-

meters in length, extending from the left bank of the river right up to Uska Bazar Railway Station 3.6 thousand hectares of land is commanded by these canals.

(8) *Rangawan Dam*. The object of this dam, constructed on the river Banne, a tributary of the Ken is to increase supplies in the Ken Canal System from irrigating an additional area of 37,200 hectares in Banda District.

(9) *Kabrai Lake Project*. Under this project an earthen dam has been constructed to store about 400 million cubic feet of water for irrigating nearly 2000 hectares of rabi area in Hamirpur district.

(10) *Ahraura Dam*. To irrigate 8800 hectares of land in Varanasi and Mirzapur districts, to protect 30 square miles of cultivated land from the ravages of floods in the Garrai River, and to supplement the discharge of the existing Garrai Canals, the construction of this 45 metres high dam was taken up towards the close of 1951. It has started serving the purposes it is meant to serve.

(11) *Narayani-Gandak-Pokhra Canal*. Taking off from the right bank of the Narayani River, a few furlongs below the Nepal border, this inundation canal has been constructed to irrigate about 40,000 hectares of land in the Maharajganj Tehsil of Gorakhpur district and about 6,000 hectares of land in Hata Tehsil of Deoria District.

A number of minor irrigation works have also been completed or are nearing completion in the State.

IRRIGATION IN MADRAS

The Madras State is another area where canal irrigation is important. Here most of the canals are in the deltas on the east coast where suitable land for canal irrigation lies. These deltas are not wet like the Ganga delta where tremendous discharge of the Ganga and the Brahmaputra rivers keeps the soil too wet to need irrigation. The greater rainfall of the Ganga delta keeps the depression filled to serve the needs of irrigation, if there is occasion for it at all.

In Madras also the canals are important as a source of irrigation than either tanks or wells. The canals irrigate about one-third of the total irrigated area here. The crops that are important under irrigation are rice, jowar, bajra and cotton.

Most of the rainfall on the east coast comes during November and December when the important summer crops have been reaped. To help these summer crops to grow during the period when the rainfall is low, canal irrigation is absolutely necessary. At this period the tanks and wells become less effective owing to smaller rainfall. The canals, on the other hand, drawing their water from rivers which have most of their rainfall during summer, are able to supply much needed water for crops.

The Delta canals of the east coast are used to a considerable extent for navigation as well. The deltas are not well provided with railway. This naturally adds to the importance of canals as means of transport in the region.

(1) *Cauvery Delta Drainage System.* The Cauvery Delta Canal is one of the oldest in India. The total length of the canal of Cauvery Delta Drainage System including channels exceeds 6400 kilometres and irrigates 4 lakh hectares of land in Tanjore and Tiruchirapalli.

(2) *Mettur Canals Scheme.* Irrigation facilities have resulted from some of the works built specially for generating hydro-electricity. Among such works the Mettur Dam in Madras State is of outstanding importance.

The Mettur Dam is built across the Cauvery river at a point 384 kilometres from its source. The Dam has been built with a double purpose : (a) to generate hydro-electricity and (b) to irrigate about 4 lakh hectares of rice fields in the Cauvery delta, 200 kilometres away from the dam. Irrigation is done with the help of about 112 kilometres of main canals together with about 960 kilometres of distributories.

(3) *Canal of Lower Bhawani Reservoir.* The Bhawani river is one of the major tributories of the Cauvery in Madras State. An area of 82 thousand hectares in Coimbatore and Tiruchirapalli Districts received irrigation during 1962-63.

(4) *The Neyyar Dam.* A Kerala-Madras project and situated about 30 kilometres south of Trivandrum. In the second stage of Neyyar Dam the total area irrigated as a result of this newly created canal is about 4,000 hectares of land. The Neyyar Cannal System commands a gross area of about 14,400 hectares, mostly in Madras State.

(5) Another example, needing much engineering skill, is that of the Periyar river whose course has been diverted from the west to the east to utilise its waters for irrigation. The valley has been closed towards the west by means of a dam 52 metres high and a lake has thus been formed. The waters of this lake are let into a canal 240 metres long through a tunnel 1¾ mile long through the mountains. The main feature of the Periyar system is the diversion of the Periyar river from the Arabian sea into the Bay of Bengal. This river has its source in the Palani Hills in Kerala whence it flowed westward into the Arabian Sea through a forested and an uninhabited country. To the east of the watershed is the Madurai district of Madras which was subjected to frequent famines. The Vaigai river is the only drainage of importance in Madurai and on its scanty and unreliable water supply practically the whole irrigation of this district depends.

The principal thing in the scheme is the dam. This is situated in a V-shaped gorge in the Hills. A lake is thus formed. From the most northerly arm of this lake the water is led for about a mile through deep open cutting to the mouth of a tunnel made across the watershed.

On the other side of the watershed a short open cut conveys the water into a natural ravine, by which it finds its way into the Vaigai. It is through the Vaigai river, therefore, that the waters of the Periyar are utilised for irrigation.

The following table XXXIII shows some important Irrigation Schemes in Madras State.

TABLE XXXIII : *Irrigation Schemes in Madras.*

Project	Irrigated Area (in hectares)	Area
Lower Bhawani	82800	Coimbatore and Tiruchirapalli
Mettur Canals Scheme	18000	Salem and Coimbatore
Manimuthar	8000	Tirunelveli
Araniar	1200 4400 Annicut	Chingleput
Amaravathi	8400 12800 Old Area	Coimbatore
Vaigai Project	5200 Dry 2800 Old	Madurai
Sathanur Project	680 320 Old	North and South Arcot
Krishnagiri	2616 New 984 Old	Salem
New Kattalai High level Canal Scheme	3443 New 4800 Old	
Pullambai Canal Scheme	12845	
Vidur	1280	
Neyyar II Stage	4000	Nagarcoil Area

IRRIGATION IN KERALA

In Malabar Coast there is but little rain from December to March. Sea breezes set in April and give rise to frequent and heavy thunder-showers which last till early June, when the true monsoon rains begin. The rainfall of the monsoon, lasting until the end of October or the middle of November, is heavy all along the coast. The annual aggregate is greatest at Mangalore, where it averages 323 cms. and decreases rapidly southwards to 168 cms. at Trivandrum. The variability of rainfall is greatest at Trivandrum (92 per cent) and least at Trichur (72 per cent). The summer monsoon rains appear in the first week of June, and continue until the middle of October. But the rain is not sufficient for plantation crops.

The following are the major irrigation projects in Kerala :—

(1) *Malampuzha Irrigation Project.* Malampuzha irrigation project, 12.8 kilometres east of Palghat, was started in 1949. The area irrigated by Malampuzha Canal is about 19040 hectares.

(2) *Walayar Irrigation Project.* 19 kilometres east of Palghat, was started in 1953. Irrigated land is 3200 hectares.

(3) *Mangalam Irrigation Project.* This project is 32 kilometres south east of Palghat and irrigated 3200 hectares of land in Palghat and Chittur.

(4) *Vazhani Irrigation Project.* This irrigation project is situated 9 kilometres east of Wadakkancherry. Irrigated land is about 3524 hectares.

(5) *Pecchy Irrigation Project.* This project is situated 24 kilometres south-east of Trichur and irrigates nearly 18400 hectares.

(6) *Neyyar Irrigation Project.* The first stage-is situated 25 kilometers south-east of Trivandrum, and irrigates about 7500 hectares of land. The second stage was started in 1956. It irrigates nearly 7600 hectares of land area in Kerala.

(7) *Periyar Valley Project.* It irrigates about 1600 hectares of land in Kottayam.

IRRIGATION IN GUJARAT

The following are the important irrigation projects in Gujarat :—

(1) *Kakrapara Irrigation Project.* This project may be regarded as the first phase of the development of the Tapti Valley. The project is situated on the rocky river bed near Kakrapara 80 kilometres upstream of Surat. It irrigates 2.27 lakh hectares in Surat district.

(2) *Ukai Project.* A new project, namely, Ukai project, scheduled to be completed in the Fifth Plan at an estimated cost of Rs. 61.20 crores will, besides irrigating 85,000 hectares, firm up the irrigation planned under the Kakrapara project. It is a power cum irrigation project. The project would stand about 112 kilometres from Surat on the river Tapti in Surat district.

(3) *Rudramata Irrigation Canal.* Started in 1957, the project has been practically completed. It irrigates 7117 hectares of land in Kutch.

(4) *Ozat Irrigation Project.* This project was completed during the year 1961 and irrigates about 6000 hectares of land in Junagadh district.

(5) *Major Irrigation Project.* The project was dedicated to the nation in 1962. It irrigates 6000 hectares of land in Rajkot.

(6) *Hathmati Reservoir Scheme.* It irrigates about 35010 hectares of land in Sabarkantha area.

IRRIGATION IN RAJASTHAN

Rajasthan, in the west of the Indian Republic, forms part of the dry Area. Having only a nominal rainfall, it is a sandy desert except in the neighbourhood of Arawalli, which intersects it from north to south and supplies water to an extensive system of canals. The following are the important irrigation projects in Rajasthan :—

(1) *Gang Canal.* It is taken out from the Sutlej at Ferozpur and irrigates nearly 3.4 hectares of land in Ganganagar Division of Rajasthan.

(2) *Bhakra Canal.* It irrigates 1.41 lakh hectares of land.

(3) *Ghaggar Canal.* It irrigates 0.51 lakh hectares of land in Ganganagar division.

(4) *Parvati Canal.* This canal is taken out from the Parvati river and irrigates nearly 3594 hectares of land in Kota division of Rajasthan State.

(5) *Pichuna Canal.* It irrigates about 3390 hectares of land in Matsya division.

(6) *Banas Canal.* The canal takes its water from Banas river in Rajasthan and irrigates 8360 hectares of land.

(7) *Bharatpur Canal.* This canal is a developed branch of Agra Canal. It irrigates about 5200 hectares of land.

(8) *Urmila Canal.* It irrigates about 1967 hectares of land in Matsya division.

(9) *Chambal Irrigation Project.* A joint venture of Rajasthan and Madhya Pradesh, the Kotah Barrage and canal is the biggest multi-purpose scheme of Rajasthan Government. The Kotah barrage has also been completed and water for irrigation was released during the year 1960.

The districts of Kotah, Bundi, Bharatpur, Sawai and Madhopur have prospered through the benefit of irrigation from Chambal irrigation project.

(10) *Rajasthan Canal Project.* The construction work of the Rajasthan canal is being done from the Harike barrage across the Sutlej near Hanumangarh. The main canal will be 640 kilometres and distributories totalling 3200 kilometers. It will benefit extensive areas in Ganganagar, Bikaner and Jaisalmer districts of Rajasthan State.

The project will be developed in two stages :—

(A) *Rajasthan Feeder.* 214 kilometres long, of which the first 176 kilometres lie in Punjab and 38 km. in Rajasthan.

(B) *Rajasthan Canal.* 366 kilometres long lying entirely in Rajasthan territory.

IRRIGATION IN MAHARASHTRA

The canal irrigation in other parts in India is not much important, either because the canals are small, as in Maharashtra or they are meant for some other purpose and irrigation is only a secondary object, as in Bengal and Bihar.

The canals of the area adjoining the Western Ghats are characterised by high dams across deep mountain valleys. Thus the valleys are converted into reservoirs from which canals are taken out. An important example of such a dam is the Bhandardara Dam in Maharashtra.

It is one of the highest dams in the world. In the trict of Ahmed-isd nagar, at Bhandardara on the Pravara river, a dam 82.35 metres high has been built to collect the high rainfall of the Western Ghats. The canals taken out from here are about 136 kilometres long.

(1) *The Pravara Canal* was constructed in 1926. It takes off at Bhandardara in Ahmednagar district of Maharashtra. It irrigates 26364.8 hectares of land in Ahmednagar district.

(2) *Mutha Canal.* The Mutha Canal was completed in 1897. It is taken out from the Mutha at Khadakwasla and irrigates nearly 4.5. hectares of land in Poona district.

(3) *The Nira Canal.* In Maharashtra irrigation on a large scale is as yet confined to the Mutha and Nira canals. The Nira canal is taken out from the Nira near Bhatghar in Poona district. It irrigates about 40 thousand hectares of land areas in Poona, Sholapur and Satara districts of Maharashtra.

(4) *Godavari Canals System.* The Darana dam was constructed in 1916 on Godavari river in Nasik district. The canal of this dam irrigates 26.6 thousand hectares of land in Ahmednagar and Nasik districts.

(5) *Girnal Canals.* Girnal Canal is situated in District Nasik at Chankapur. It irrigates about 4.1 thousand hectares of land in Nasik.

(6) *Gangapur Dam.* The first stage was completed and it irrigates about 18,000 hectares of land in Nasik.

(7) *Tapti Canal System.* A joint venture of Gujarat and Maharashtra, the Tapti Valley Project is an irrigation project. It irrigates about 3 lakh hectares.

The medium and minor irrigation projects also play a very important part in the development of the State. The following table XXXIII shows the important irrigation Schemes in Maharashtra State.

TABLE XXXIII : *Irrigation Schemes in Maharashtra.*

Project	Area Irrigated (hectares)	District benefited
Vir	26400	Sholapur and Satara
Ghod	24080	Poona and Ahmednagar
Bor	10500	Wardha
Nalganga	10800	Buldana
Katepurna	9600	Akola
Dina	12200	Chanda
Purna	50800	Nanded and Parbhani
Manar	10000	Nanded

IRRIGATION IN ANDHRA PRADESH

The following are some important irrigation projects in Andhra Pradesh :

(1) *Bhairavani-Tippa Project.* It takes its water from Bhairavani and irrigates about 121276 hectares of land in Krishna, Guntur, Nellore and Anantapur districts.

(2) *Romperu Canal.* This canal was constructed in First Plan period and takes water from Romperu river. It irrigates 3278 hectares of land.

(3) *Pennar Project.* It irrigates about 12 lakh hectares of land.

(4) *Nagarjunasagar Project.* The project in its first stage comprises the construction of a 1450 metre long masonry dam on the Krish-

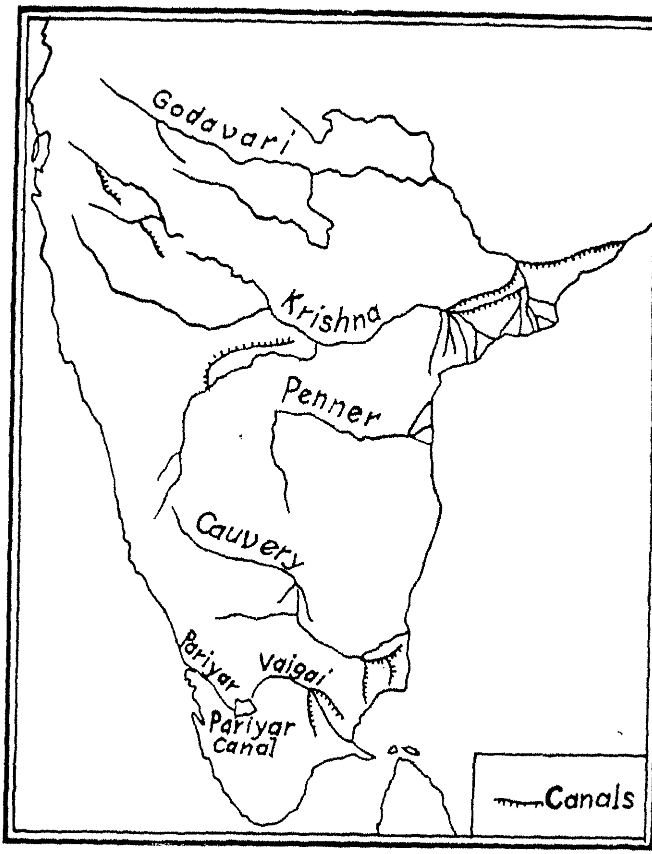


Fig. 24. Irrigation canals in Southern India.

na river near Nandikonda village, and two canals taking off from the reservoir, known as left and right bank canals. The right bank canal

which will be 204 km. long will carry a discharge of 11,000 cusecs in the first stage. The left bank canal will be 178 kilometres long and will lead up to the river Muneru in the first stage, and will flow through Telangana. Both the canals will together irrigate 8.1 lakh hectares including stabilisation of irrigation in Krishna Delta. The dam and the canal are expected to be completed in 1970-71.

(5) *Tungabhadra Project.* This joint undertaking of the Governments of Andhra Pradesh and Mysore comprises a 2,450 metre long and 49.30 metre high dam on the Tungabhadra river at Mallapuram; a 203 km. long canal (called the left bank canal) with a power house on the left side; a 347 km. long canal (called the low level canal) and 195 km. long canal (called the high level canal) on the right side.

The districts of Gulbarga, Mahbubnagar, Raichur *etc.*, have prospered through the benefit of irrigation from the Tungabhadra project.

IRRIGATION IN MYSORE

The surface is diversified by highland areas separated by generally wide valleys, and is bounded on the east and west by the Eastern and Western Ghats. Of these, only the Western Ghats form a serious barrier in rainfall. As the wind travels eastward, the rainfall diminishes, and is scanty in Mysore. As the South-West monsoon does not blow strongly east of Western Ghat, the Mysore state is deficient in rainfall, and irrigation is necessary for cultivation. The following are the important irrigation works in Mysore State :—

(1) *Tungabhadra Project.* The Tungabhadra project is the largest multipurpose project in Mysore State. About 332000 hectares of land was irrigated by the left bank canal in 1963-64 and 36936 hectares of land in Bellary district was irrigated by low level canal.

(2) *Rajolibanda Scheme.* It irrigates about 2760 hectares of land in Raichur district of Mysore.

(3) *Bhadra Reservoir Scheme.* It takes off from the Bhadra river near Chickmagalur and irrigates about 9765 hectares of land.

(4) *Tunga Anicut Project.* It is situated in Shimoga district and irrigates 8400 hectares of land.

(5) *Ghataprabha Project.* About 36000 hectares of land in Bijapur and Belgaum district is irrigated by the 1st stage of Ghataprabha project. 71200 hectares of land is totally confined in Bijapur district.

(6) *Malaprabha Project.* Malaprabha is a tributary of Krishan in Belgaum district of Mysore state. The right bank canal of the project will irrigate 1.2 lakh hectares of land in Dharwar, Belgaum and Bijapur districts.

(7) *Upper Krishna Project.* The main canals taking off from the Upper Krishna project, totalling a length of 392.6 km. will irrigate 24,282 hectares.

(8) *Bhadra Reservoir Project.* This multipurpose project across the river Bhadra in Mysore state, will irrigate 99,015 hectares of land in Shimoga, Chikmagalur, Chitradurga and Bellary districts. Fig. 24 shows the canal irrigation in Southern India.

IRRIGATION IN BIHAR

The area under assured irrigation before the inception of the First Plan was 3.6 lakh hectares in South Bihar and 5.2 lakh hectares in North Bihar. Area added during First Plan was 9.2 lakh hectares in South Bihar and .3 lakh hectares in North Bihar. Target for the Second Plan was 2.5 lakh hectares in South Bihar and .44 lakh hectares in North Bihar. Following are the important canals in Bihar State.

(1) *Sone Canal System.* This is the main canal in Bihar State. It takes water from Sone river at Dehri. The right bank canal takes its water from Barun. The districts of Gaya, Patna and Shahabad have prospered through the benefit of irrigation from the Sone canal.

Western Canal of Sone. Just opposite the right bank canal of Sone another artificial stream of water was taken out of the Sone. Its main branches are (1) Ara Canal, (ii) Buxor, (iii) Chosha branch.

Sone canal irrigates about 3,44,000 hectares of land.

(2) *Kosi Project.* The eastern Kosi canal system at an estimated cost of Rs.16.42 crores is proposed to have an annual irrigation of about 5.6 lakh hectares in the districts of Purnea and Saharsa. The system consists of a main canal, four branch canals and a number of tributaries.

The extension scheme of eastern Kosi canal is eastimated to cost Rs. 4.67 crores. It comprises the construction of a canal system taking off from the eastern Kosi main canal to irrigate 1.60 lakh hectares in Saharsa and Monghyr districts.

Western Kosi Canal. This scheme is estimated to cost Rs. 18.38 crores and comprises the construction of a main canal, 112 km. long taking off from the right flank of the Kosi barrage to irrigate 3.12 lakh hectares in Darbhanga district of Bihar and 12,120 hectares in Saptari district of Nepal.

(3) *Gandak Project.* It is an inter-state project in which Bihar and Uttar Pradesh are the participating states and Nepal would also derive irrigation and power benefits from it.

The main Eastern Canal is to irrigate 6.03 lakh hectares of land in the Champaran, Muzaffarpur and Darbhanga districts of Bihar, and 0.42 lakh hectares in Parsa, Bara and Rautuhat districts of Nepal.

The main western canal is to irrigate 4.84 lakh hectares in the Saran district of Bihar, and about 3.44 lakh hectares in the Gorakhpur and Deoria districts of Uttar Pradesh. A separate canal will also take off

from the western bank to irrigate 16,605 hectares in the Bhairwa district of western Nepal.

IRRIGATION IN BENGAL

During 1964-65 intensive agricultural programme was introduced in 116 blocks of 9 districts of Bengal. An intensive agricultural programme, commonly known as package programme was launched in the district of Burdwan from Aug. 1962, and good results appear to have been achieved as manifested by the rise in production of paddy to the extent of 13 per cent. and 4 per cent. respectively in 1963-64 and 1964-65 over the preceding years.

Mayurakshi Project. During the kharif season of 1965-66 an area of about 200,000 hectares was irrigated by the Mayurakshi Reservoir project against the target of 204,000 hectares. A special drive to irrigate 16000 hectares during the Rabi season was also taken.

Kangsabati Project. It has advanced considerably and though still under execution stage, supplied water to about 27600 hectares during the kharif season. In general this project provides water for Purnea, in Bihar and Bakura and Hoogly districts of West Bengal.

Damodar Valley Corporation. The total length including channels exceeds 2344 kilometres and irrigates 80,000 hectares of land in Hoogly, Asansol and Burdwan districts of West Bengal.

The operation and maintenance of Durgapur barrage and irrigation system was transferred to the Government of West Bengal from April 1,1964. Nearly 137 kms. of the main left bank canal have been made navigable. Under an agreement with the corporation, the Hindustan Shipping Co. Ltd., Calcutta have started a bi-weekly cargo service between Durgapur and Calcutta.

The following table XXXIV shows the important irrigation works in the Indian Republic.

TABLE XXXIV : *Important Irrigation Works.*

State & Project	Area irrigated (000 hectares)	State & Project	Area irrigated ('000 hectares)
Andhra Pradesh		Bhairavani tippa	6.88
Godavari Delta System	449.64	*Bihar*	
Nizam Sagar	11 .29	Sone Canal	347.23
Romperu drainage	4.01	Kamla Canal	15.38
Rallapad	4.45	Mayurakshi left bank canal	10.12
Upper Pennar	3.93	Tribeni Canal extension	25.13
K.C.Canal	112.51	Nagi dam	3.04
Godavari (Stage 1)	26.31	*Gujarat*	
Prakasam barrage	44.11	Rangola	7.89

Brahmani	10.93
Maj	6.07
Aji	1.70
Machul	8.90
Jammu & Kashmir	
Sind Valley	7.28
Kerala	
Kuttand	48.98
Peechi	28.08
Chalakudy (Stage I)	22.99
Walayar Reservoir	6.47
Wadakancheri (Vazhani)	7.12
Nayyar I	15.38
Malampuzha	40.47
Madhya Pradesh	
Tandula Canals	65.76
Mahanadi Canals	84.09
Sampna	3.84
Gungulpara	3.44
Madras	
Periyar System	9.19
Kaveri Mettur	134.36
Perinchari	47.4
Lower Bhavani	78.92
Mettur Canals	18.16
Araniar Reservoir	—
Krishnagiri	3.64
Sathanur	8.47
Amaravathy	21.65
Kattalai high level canal	8.32
Pullambadi canal scheme	8.94
Maharashtra	
Nira left bank canal	33.46
Pravara river works	33.86
Nira right bank canal	32.85
Gangapur Reservoir	18.21

Mysore	
Krishnaraja Sagar dam & canal	40.47
Tunga anicut	8.70
Nugu	8.09
Ghataprabha left bank canal	48.56
Orissa	
Rushi Kulya canal System	45.00
Punjab (united)	
Upper Bari Doab Canal	335.17
Western Yamuna Canal	48.94
Sirhind Canal	600.17
Eastern Canal Extension	97.13
Western Yamuna Canal extension	48.97
Nangal barrage	11,12.92
Dadri	Linked with Yamuna canal
Rajasthan	
Jawai project	7.69
Prabhati project	12.14
Meja project	9.71
Sareri	5.26
Namona	4.45
Uttar Pradesh	
Upper Ganga Canal	690.01
Lower Ganga Canal	465.93
Betwa Canal	83.30
Ghagar Canal	22.20
Sarda Canal	795.00
Sarda Canal extension	71.23
Mata tila (Stage I)	165.20
Belan and Tons Canal	25.81
Agra Canal (remodelling)	67.50
Ban Ganga Canal	41.00
West Bengal	11.09
Damodar Canal	80.94
Mayurakshi	246.87

WELL IRRIGATION

The well may be said to be the indigenous form of irrigation in India. It is very well suited to the poor Indian farmer, because it is cheap to build, requires no elaborate machinery to work it, and does not need any specialised engineering skill to build it or to work it. It

can be dug at the very door of the farmer, if necessary. Well digging needs no elaborate survey of levels as is necessary for canal construction. A simple "kachcha" well costs very little in most of the districts, and is, therefore, within the means of the poorest of farmers. A canal, on the other hand, costs lakhs of rupees and can be undertaken, in a poor country like India, only by the Government.

Apart from this economic consideration, well irrigation is suited to a large part of India on geographical consideration also. Over a large part of the country the soil consists of a sandy loam underlain here and there by isolated beds of clay which appear floating in a sea of sand that is highly saturated with moisture that percolates through the soil. These clay beds act as reservoirs which when tapped bydigging, supply large quantities of water which can easily be lifted to the surface. The geological formation of India is too simple to provide opportunities for 'artesian wells' where the pressure of water underneath is so great that it comes to the surface automatically. In some localities where the above mentioned clay beds are thick enough, much larger supplies become available in the well by boring a hole (tube-well) through the clay than are possible in the ordinary 'spring well'. These 'tube-wells' are expensive to build, and, to be effective, need machine power to lift large quantities of water.

The factors governing the supply of water to the underground which feeds the wells are :—

1. Local rainfall;

2. Slow seepage from the land lying at the base of the mountains or Terai, where the rainfall is higher;

3. Seepage from canals and canal-irrigated lands and seepage from other water bodies.

Well irrigation in India is limited by :—

(a) Water level is too low in certain areas. This is particularly found in the neighbourhood of rivers. It appears that water level sinks deep near the river banks to rise in the river bed. No generalisations are possible with regard to the water table in India as the subject has not yet been studied. Those districts in which the rainfall is very heavy usually have a high water table and water is very near the surface. In other districts, where the rainfall is limited water table is low and the wells have to be very deep.

(b) The second limitation is the brackishness of the well water. Brackish water is useless for irrigation as it destroys the crop. No data are available in this respect also; but it appears that brackish water may appear anywhere, even in a locality where other wells are sweet. The districts where water is usually brackish have very little well irrigation.

(c) The third limitation is that a large number of ordinary wells dry up during periods of drought when their water is needed most. They also mostly dry up after a few hours' excessive lifting of water and are, therefore, unable to irrigate large area.

Well irrigation is mostly confined to—

First. Middle Valley of Ganga—Eastern districts of Uttar-Pradesh particularly Bahraich, Gonda, Basti, Faizabad, Sultanpur, Rae Bareilly, Pratapgarh, Jaunpur, Varanasi, Azamgarh, Ghazipur, Ballia, Gorakhpur and Deoria.

In Bihar the areas which will still be beyond the command of canals and wells have been constructed. The wells are serving 306.4 thousand hectares of land in Shahabad, Gaya, Patna, Saran, Muzaffarpur, Bhagalpur and Monghyr districts of Bihar.

Well irrigation is also important in West Bengal particularly in Purulia, Bankura, Burdwan, Birbhum and Murshidabad districts.

In Southern India well irrigation is of considerable importance in Southern part of Madras State and Eastern parts of Nilgiri and Illayachi Hills especially Coimbatore, Madurai, Ramanathpuram, and the areas between Tiruchirapalli to Guntur in the north.

Well irrigation is also found in Maharashtra especially in Kolhapur, Sholapur, Ahmednagar and some limited parts of Poona district.

Well irrigation is also of considerable importance in the Sub-Montane districts of the Punjab. Well is also found in the Regions of the Black Cotton Soil, especially where it is deep.

The regions immediately in the neighbourhood of the Himalayas, the Assam and Arakan Hills, and to the west of Western Ghats are particularly deficient in well irrigation.

Well irrigation accounts for about 30 per cent. of the total irrigated area in India. The most important States in order of importance are U. P., Bombay, the Punjab, Rajasthan and Madras. Even in canal-commanded areas well irrigation is practised in elevated parts where the canal water cannot reach.

The following table XXXIV shows the well-irrigation in India.

TABLE XXXIV : *Well Irrigation*, 1962-63.

State	Thousand hectares
Andhra Pradesh	428.8
Assam and NEFA	—
Bengal	15.6
Bihar	306.4
Gujarat	443.6
Jammu & Kashmir	2.0

Kerala	2.0
M. P.	338.4
Madras	587.2
Maharashtra	624.4
Mysore	153.6
Orissa	23.6
Punjab	1010.8
Rajasthan	1053.6
Uttar Pradesh	2430.8
Delhi	16.4
Himachal Pradesh	200.0
Manipur	—
Tripura	—
Andaman & Nicobar Islands	—
Laccadive Mini. & Amindivi	—

TUBE-WELLS

The U. P. Government bored a number of tubewells to extend irrigation in areas where canal water could not reach. These tubewells are worked by electricity. The drawing of large quantities of water from the tubewells raised the question whether the water table of the province will be lowered and thereby dry up a number of the ordinary spring wells. The question has been enquired into by Mr. Auden whose report is summarised below :—

The areas in which tubewell pumping is contained should not be considered as isolated units independent of the neighbouring areas they should be regarded as part of the Gangetic alluvial system, which east of the submerged extension of the Aravallis from Delhi towards Dehra Dun, occucrs in a single basin almost certainly without under ground barriers of any magnitude. Continuity of the alluvium in this basin permits the greater rainfall supply of the Terai belt being operative as a means of replenishment in the area to the south. The boring of the tubewells has proved that sand predominates over clay in the sub-soil of this basin. The water in these sands occurs as a continuous reservoir, which must be connected with the strata below the Terai where the rainfall is greater. There is, therefore, a considerable excess of rainfall over the water removed by pumping.

These tube-wells are usually 91 metres deep in the districts of Azamgarh, Ballia, Ghazipur, Jaunpur and Varanasi, where the strata consist mostly of clay and they may have to be sunk as deep as 152 m. Special boring machines have been ordered for the purpose from abroad.

The average discharge of a well may be taken as 30,000 gallons per hour and with this supply five acres will be irrigated in 24 hours with a field water depth of four inches. Water of one tubewell usually commands an area of about 400 hectares, irrigating about 160 hectares annually, *i.e.*, 600 hectares of sugarcane and kharif and 100 hectares of rabi. To irrigate and 'mature' this area, the well should run 3,200 hours annually.

For successful tubewell irrigation are needed : (i) the area must be in alluvial formations where water bearing strata at various depths are found; (ii) cheap power for lifting water must be available, (iii) the soil should be of good quality so that high costs involved in the operation of tubewells are compensated by large produce.

For carrying the tube-well water to various parts a net-work of channels, called "Guls," is constructed and each tube-well has one mile of brick-lined and two miles of unlined Guls.

As regards distribution of water for irrigation, when demand is not full, cultivators get water as soon as they ask the tubewell operator for it. When the demand is full everyone wants to be served first and for such periods of keen demand, a system of distribution of water, called the 'Osrabandi', is drawn up for each well, under which turn as well as time of each group of cultivators is fixed and water is distributed by the operator, accordingly. The districts of Bahraich, Gonda, Basti, Gorakhpur and Deoria on the north of the river Ghagra and Faizabad, Sultanpur, Azamgarh, Ghazipur, Ballia, Jaunpur and Varanasi on the South, have very little irrigation works. They depend almost entirely on rainfall and whatever irrigation is done from open wells, tanks, 'jhils' or 'tals' and rivers.

The comparatively high rainfall of these districts, when well distributed and timely, is more than adequate for the requirements of the crops in general and it was mainly for this reason that irrigation schemes, when prepared, were not taken up for execution in the past.

GANGA-GHAGHRA DOAB

When the Sarda Canal scheme was taken up, a provision was made to irrigate also the whole of the Ganga Ghaghra Doab, down to Varanasi and Ballia, but the waters of the Sarda were subsequently found insufficient for all this area and, consequently, the eastern districts lying in this Doab were left out. In 1937 the Ghaghra canal was constructed in the district of Faizabad by pumping water from the Ghaghra but the scheme did not prove remunerative with the irrigation rates without the surcharge.

As it was not found feasible to construct gravity canals for these eastern areas, various projects for pumped canals, proposing to utilise the waters of the Ghaghra, the Ganga and the Rapti, were prepared

from time to time but they were not taken up particularly because the spring levels in the area being comparatively high, it was feared that the introduction of canal irrigation might result in further raising the subsoil water table, thus affecting the productivity of the soil adversely as well as the health of the people. Most of these districts are also liable to floods in varying degrees and this again indicated that canals were, in general, not suitable for such areas.

The Government, therefore, decided to construct tube wells and in the First Five-Year Plan construction of 2,000 tube-wells was completed in the following districts :—

Bahraich, Gonda, Basti, Gorakhpur, Deoria, Faizabad, Sultanpur, Azamgarh, Jaunpur, Ghazipur, Ballia, Varanasi, Etah, Mainpuri and Farrukhabad.

The work was completed on the Sarda Canal reservoir in the catchment area of the Chauka river designed to maintain an annual supply of 8,276 million cubic feet of water.

Nearly 60,000 hectares of land is being irrigated in the eastern districts ensuring additional production of foodgrains amounting to 10 lakh maunds.

This was part of the larger plan to extend the Sarda Canal and its channels in the districts of Rae Bareli, Pratapgarh, Sultanpur and Jaunpur and raise their capacity to ensure the flow of a larger volume of water.

Such areas in western region of U. P. which shall still remain beyond the reach of canals are proposed to be served by tube-wells. Already 906 tube-wells have been constructed to irrigate about 120000 hectares of land in Kashipur, Moradabad, Rampur, Bareilly, Pilibhit, Meerut, Agra *etc.*

In the Central Region which will still be beyond the command of canals, 340 tube-wells have been constructed. These tube-wells are serving 36000 hectares of land in Kheri, Sitapur, Shahjehapur, Bareilly and Lucknow districts. By the hand of second Plan period the number of tube-wells was 600.

Irrigation with these tube-wells has developed satisfactorily in Hissar, Patiala, Ludhiana, Kapurthala and Gurgaon districts of Punjab.

In the Deccan, water-bearing strata are seldom found except in faults and fissures in the rock. The exact location of an underground stream is necessary for any successful boring. This is where the help of a geologist is required and a water divider may also help. Twenty-one tube wells with an aggregate discharge of about 400,000 gallons per hour have been made for the Ahmedabad mills.

Sub-artesian tube wells are those in which water requires pumping. Sub-artesian water is generally obtainable between 75 m. below surface, while for artesian flow, the boring requires to be carried down to between 182 to 304 metre below the surface.

A fine example of an artesian bore may be seen at Chhaloda near Ahmedabad. Here a boring was put down 258 metres deep and yields a water supply of 650,000 gallons per day. This waters comes up the tube under great pressure and has been flowing day and night for the last several years. The travellers from Ahmedabad pass through miles of dry sandy soil and on approaching Chhaloda appear to have come upon an oasis in the desert. The water has formed lakes round the village. The actual cost of the water comes only to 1 pie per 1,000 gallons.

The Government of India entered into an agreement with the U.S. Government, under the T.C.A. programme, for the construction of 4208 tube wells in India. All these tubewells were constructed along the Gangetic plain but as considerable interest was shown in the results obtained here by other states, it was decided to explore the possibilities of tubewell construction in other parts of India where flow irrigation is not possible and where water is needed for irrigation.

A project for exploring these areas was, therefore, prepared under the 1953 Indo-American Technical Aid Programme under which the following areas considered by the Geological Survey of India as offering the best possibility of underground water were taken up for exploration by actual drilling. Narmada Valley (M.P.), Tapti Basin (Gujarat and Madhya Pradesh States), Purna Basin (Maharashtra), Rajasthan, Kerala, Madras, Kutch, Andhra Pradesh, Bihar, Punjab, Orissa and U.P.

TANK IRRIGATION

About 18% of the total irrigated area of India is accounted for by the tanks, a little less than half of it being in the states of Madras and Andhra. The only areas important for tank irrigation outside the Deccan tableland are in North Bihar and Southern U.P. The undulating topography of the Peninsular region, and the depression provided by the old beds of rivers in North Bihar are converted into tanks by deposits of rain water. Like the well irrigation, the tank irrigation also suffers from uncertainty of rainfall over most of the areas where tanks are common.

Tank irrigation is very important in Andhra, Madras, Orissa, and Uttar Pradesh where over 13.1, 9.2, 4.1 and 4.3 thousand hectares respectively, are irrigated by tanks. The following table XXXV shows the tank irrigation in India.

TABLE XXXV : *Tank Irrigation* 1962-63

State	Irrigated area (Thousand hectares)
Andhra Pradesh	1315.2
Assam & NEFA	—
Bengal	364.0
Bihar	285.6
Gujarat	17.0
J. & K.	—
Kerala	48.8
M. P.	170.8
Madras	928.8
Maharashtra	197.2
Mysore	366.4
Orissa	412.4
Punjab	6.8
Rajasthan	119.6
U. P.	434.4
Delhi	5.2
Himachal Pradesh	—
Manipur	—
Tripura	1.2
Andaman & Nicobar	—
Laccadive & Amindivi	—

EXTENSION OF IRRIGATION

The importance of irrigation is not the same for all crops grown in India. The crops which have to be in the field during the dry period of the year are naturally the most irrigated crops in India. But owing to the considerable labour and expenses involved in irrigation only the most paying crops are irrigated first. Thus, sugarcane, cotton and wheat are generally the most important for irrigation. Cotton is, however, less irrigated than sugarcane, chiefly because it is grown mostly in the Black Cotton Soil. This soil is difficult to irrigate owing to cracks in it and owing to fewer facilities for irrigation being present in that area. Important areas of irrigated cotton occur generally in the Punjab and in Madras.

If irrigation facilities were available, about two-third of the area under wheat could benefit. This would increase the yield and, therefore, the total output of wheat in India.

The progress of irrigation in India is not rapid. Irrigated areas cover only 17% of the total sown area in the country. There is a great scope for irrigation in West Bengal, Bihar, Orissa, U. P. and Bombay.

The growing need for extending irrigation facilities in India is further shown by the following table which gives the proportion of the total cultivated area that receives irrigation in certain areas :—

Proportion of Irrigated to Cultivated Area

State	% Irrigated to cultivated	State	% Irrigated to cultivated
Assam ..	23	West Bengal ..	19
Bihar ..	16.5	Kerala ..	20
Bombay ..	6	Andhra ..	29
Punjab ..	41	M. P. ..	5
Madras ..	40	Mysore ..	7
Orissa ..	14	Rajasthan ..	21
U. P. ..	27	J. & K. ..	38

It is clear, therefore, that extension of irrigation facilities is the primary need of Indian agriculture.

DEVELOPMENT UNDER THE THIRD PLAN

It is proposed to bring 5.12 crore hectares of cultivable land under irrigation during the 3rd Plan as against 36 lakh hectares during the 2nd Plan. The total expenditure on the project is estimated at Rs. 250 crores. To meet this heavy expenditure it has been suggested to invest all the savings under agricultural production sector to this scheme, besides, giving financial aid wherever necessary. Instructions have been issued to the authorities concerned for maintenance and protection of existing canals, head-work and feeding channels. Further new surveys and planning are also being encouraged to keep up the sprit of the plan and to bring new areas under irrigation. The following table XXXVI shows the principal irrigation projects in the 3rd and 4th Plans.

TABLE XXXVI : *Principal Irrigation Projects in 3rd Plan*

Projects	Annual Benefits On completion	(000 hectares) By the end of III Plan
Continuing Schemes		
Bhakra-Nangal	1,456.92	1,456.92
Damodar Valley	416.03	394.18
Hirakud Stage I	242.82	242.82
Chambal Stage I	445.17	407.53
Tungabhadra	332.26	259.82
Mayurakshi	246.87	228.66
Bhadra (Mysore)	97.94	48.56
Kosi	568.60	107.24
Nagarjunsagar	809.40	234.32
Kakrapara Canal	264.67	181.71
Rajasthan Canal	1163.51	121.41
Tungabhadra high level	76.49	25.70
Canal Stage I	76.49	25.70
Ukai	158.4	—
Tawa (M. P.)	318.90	—
Purna (Maharashtra)	61.51	61.51
Narmada (Gujarat)	403.09	—
Banas ,,	44.52	44.52
Mula (Maharashtra)	88.63	—
Girna ,,	57.06	40.47
Khadakvasala ,,	28.33	—
New Kattalai (Madras)	8.50	8.50
Salandi (Orissa)	132.74	24.28
Gurgaon Canal (Punjab)	111.29	—
Kangsabati (W. Bengal)	384.46	80.94
Chandrakeshar (M.P.)	4.86	
Kabini (Mysore)	20.23	—
Banas (Rajasthan)	64.75	—
Bhadar (Gujarat)	18.21	5.42
Boothathankettu (Kerala)	40.87	20.23
Lidder Canal (J. & K.)	3.24	—

Barna (M.P.)	66.37	—
Laxamanthirtha (Mysore)	2.83	—
Vidur (Pondicherry)	1.21	1.21
Ram Ganga (Uttar Pradesh)	690.42	—
New Schemes—		
Vamsadhara (A. P.)	134.76	—
Vottigedda („)	4.53	0.40
Krishna Irrigation Scheme	123.84	—
Bhima Irrigation Scheme	170.78	—
Pus river scheme (Maharashtra)	10.12	—
Malaprabha Project (Mysore)	121.41	
Hemavathi Project (Mysore)	13.35	—
Anandpur barrage (Orissa)	90.63	—
Jamuna Irrigation Schemes (Assam)	32.78	—
Western Kosi Canal (Bihar)	325.38	—
Tista Multipurpose Barrage (W. Bengal)	—	—
Hasdeo Project barrage (M.P.)	—	—
Beas Project	619.19	—
Gandak Canal	1,319.73	—
Sarju Canal (U.P.)	253.75	—
High level canal from Vishow to Nawkarawa (J. &. K.)	6.07	—
Kallada (Kerala)	105.22	—
D.V.C.—extension & improvement *etc.*	—	—
Baur (U.P.)	19.02	4.05
Jamni (U.P.)	12.55	—

The total target proposed for the Third Five Year Plan is 5.12 million hectares. This will consist of 3.80 million hectares under the G. M. F. Programme and 1.32 million hectares under the C. D. Sector. The total financial provision made under the G. M. F. sector is Rs. 177 crores. It is expected that about Rs. 66 crores will be available for minor irrigation under the C. D. Sector. The total financial outlay on minor irrigation in the Third Plan may thus be in the neighbourhood of Rs. 290 crores, *i.e.*, about double of that under the Second Plan.

QUESTIONS

1. Why is irrigation so necessary for Indian Agriculture ?

2. How far do geographical factors help the practice of irrigation in India ?

3. Why are canals more popular sources of irrigation than wells or tanks in India ?

4. Briefly describe the important canal system of (a) Punjab and (b) U.P. emphasising the nature of the country they serve.

5. What factors, geographical and economic, favour well irrigation in India ?

6. Will the power-worked tube-wells in U. P. affect adversely the water table ?

7. Why is it more difficult to dig wells in the Deccan than in the Ganga Valley ?

8. Write a short note on :—

   (a) Mettur Dam.

   (b) Bhandardara Dam.

   (c) Irrigation in the Punjab.

CHAPTER 9

Land Utilization

The main objective of this chapter is to analyse from the data available, the general pattern of land utilization in India, *i.e.*, the pattern of distribution of land among its important uses like cultivation, grazing, forestry, settlements, *etc.* An attempt has also been made to assess the possibilities of securing more intensive use of the land resources, and in particular of increasing the area under cultivation. Cultivation, grazing and forestry are the three main uses of land. Most of the land in the Indian Republic is occupied by these three uses. Other uses of land, *e. g.*, towns and villages, roads and bridle-paths, canals, *etc.*, although very important from the economic standpoint, occupy relatively small areas.

Of the three main uses, cultivation is the most intensive, and there is a tendency in all States, as population increases and demands of food supply grow, to bring as large areas as possible under cultivation. This tendency is particularly strong in old and densely populated States like Kerala and West Bengal in which the pressure of population on land is very high. However, the possibilities of cultivation are limited by physical factors like inadequate or badly distributed rainfall, hilly and mountainous terrain, thin or infertile soils, so that large areas in every state are under forests or grazing lands, or lie barren and unproductive. The pattern of land utilization in India is conditioned by two sets of factors—

(1) the physical factors like climate, topography and soils which set the broad limits upon the capabilities of the land, and

(2) the human factors like length of occupation of the area, density of population, social and economic factors (especially systems of land tenure) and the technological levels of the people, which determine the extent to which the physical capacities of land are utilized.

In newly settled sparsely populated regions of northern India like Bhabar and Terai there are still considerable areas in which land utilization can be more intensive. Large areas which are at present used for grazing or are under forests can be brought under cultivation, if populations increase and the demands on land are greater than they are today. But, in old densely populated states, where adjustment to the physical environment has been going on for ages and the pressure of growing populations has operated to bring under use all land that is usable, the pattern of land utilization comes much closer to the phy-

sical capabilities of the land. Thus in Indian Republic, increases in agricultural production have to come mainly through increased production from the lands already under cultivation. Increases resulting from increased area under cultivation can only be limited for the simple reason that the additional acreage which can be brought under cultivation are comparatively small. Improvements in the pattern of land use are essential for improving physical and hydrographic conditions and for controlling soil erosion, and other problems, not so much for increasing production.

The general pattern of land utilisation in different states of the Indian Republic is shown in table XXXVII.

TABLE XXXVII: *Classification of Area*

In thousand hectares 1962-63.

States	Forests	Area not available for cultivation	Uncultivated excluding Fallow	Fallow land	Total Cropped area
Andhra Pradesh	6046.4	3980.0	2793.2	2828.0	12693.6
Assam	4816.8	5630.8	1455.2	98.8	2717.6
Bengal	1089.4	1277.6	632.0	378.0	6280.4
Bihar	3666.0	2213.2	961.2	2022.4	10953.6
Gujarat	1097.4	5063.2	1783.6	706.8	8010.0
J. & K.	3098.8	568.8	384.0	122.4	819.2
Kerala	1044.0	331.6	366.4	86.0	2418.4
M. P.	13982.4	4044.8	7172.4	1992.8	18193.6
Madras	1856.2	2166.0	1297.6	1592.0	7185.6
Maharashtra	5364.8	2491.2	2460.8	3294.0	18744.0
Mysore	2658.4	1749.2	2667.6	1242.0	10636.8
Orissa	3563.2	2869.6	2142.6	774.0	6389.2
Punjab	365.6	3242.4	554.8	457.6	9913.6
Rajasthan	842.4	5888.0	8174.4	626.8	14661.6
U. P.	3681.6	4442.4	2454.0	1423.2	21709.6
Delhi	1.6	34.4	17.6	6.4	108.8
Himachal Pradesh	763.2	529.2	1204.8	16.8	437.6
Manipur	595.2	1392.4	21.2	.4	168.4
Tripura	628.0	42.8	147.6	10.8	263.6
Andaman & Nicobar	640.0	6.8	9.6	1.6	9.6
Laccadive Minicoy	—	—	—	—	—
Total	56005.2	48344.4	36702.4	30680.8	155309·6

It will be seen from this table that the highest proportions of arable land are in Uttar Pradesh and Maharashtra. In the latter, favourable natural factors like moderate rainfall, gentle slope with fairly fertile top-soils, combined with the high levels of cultural and other developments attained by the people account for the very large percentage of arable land and relatively small areas of barren and unproductive lands. In the north, the high proportions are due primarily to the existence of fertile Gangetic plains. Climatic conditions in this region are not so favourable as in coastal regions. Rainfall in most of the regions is concentrated in a short period of the year, is precarious and over large acreas insufficient for cultivation.

At the other extreme from North and North-east regions of the Indian Republic, in which proportions of arable areas are barren and unproductive, a large part of this is steep and other large areas are used for grazing. In the north western regions, large areas are occupied by forests and grass-lands. Considerable possibilities of extension of cultivation exist in Madhya Pradesh, and as populations grow and demands on land increase, the areas under cultivation will undoubtedly increase.

According to H. Graham, "to think wisely of the future use of land, we must first look carefully at its past, for a knowledge of what has caused a landscape helps materially in judging its future. Once we understand a landscape's history, we are better prepared to consider how wise or unwise has been the use to which that land was put. Then with a knowledge of climate, soils, vegetation, and other habital factors, we can gauge something of the potential productivity of the area". Before we make an attempt of throwing light upon the present trend of land utilization in India, we shall have to consider the numerous changes that had taken place during the past fifty years. Surveys regarding these changes in land use undertaken in some states of India indicate that there have occurred slight changes in the pattern of land use in India which are indicative of the general trend in land use during the past fifty years.

Trends in Land Use Pattern

Due to changes in coverage it is difficult to obtain comparable data for the Indian Union as a whole over a sufficiently long period to indicate trends. A study of the data for some of the states where only slight changes in coverage have occurred, was, therefore, undertaken over a period of about fifty years which brings out the following trends :—

1. The net area sown has not increased appreciably except in Uttar Pradesh. The area growing more than one crop has increased by about 26% and the total cropped area, therefore, shows some increase which, however, lags far behind the rapidly increasing population.

2. Irrigated area has increased by about 17% mainly through the extension of canals. It has been noticed that the area irrigated from minor irrigation works has remained somewhat static over this long period. It seems to indicate that the new constructions have at best kept pace with works going out of use for want of repairs or otherwise *e.g.*, though extension of canal irrigation.

3. The area under current fallows remained at the level of 1930-31 till the 'forties and thereafter showed some increase, particularly in the cotton growing tracts, possibly because of a sudden decrease in cotton area which was left partly fallow. Andhra Pradesh is the only State which shows a continuous increase in fallows.

4. The sudden increase in the area under cultivation is somewhat of an exaggeration in Rajasthan. West Bengal is the only State which shows a continuous increase in agricultural acreage.

Another study of trends in crop pattern was based on the data relating to the main growing areas of different crops. This indicates the following trends—

1. The area under food grains shows a small increase during the forties when the area under cotton declined.

2. During the periods of the two world wars the acreage under cotton decreased. This trend was reversed in the post-war periods.

3. Area under oil seeds, mostly ground nuts has steadily increased by 7,072 thousand hectares.

4. A considerable increase of about 841 thousand hectares has occurred in Jute area since partition because of the intensive efforts made to fill the large gap created in the supply position after Partition.

5. The area under sugarcane has increased by about 2.544 thousand hectares. A steady increase, though small in extent, is noticed in the area under cane in Madras and Maharashtra.

The above trends bring out two main facts of the agricultural situation, namely that

(i) although gross cropped area has increased as a result of double cropping, little new area has come under cultivation during the last fifty years and

(ii) changes in price structure do affect the pattern of crops even though a large part of the area is cultivated in tiny holdings. A part of the area of cultivable waste can be utilised for extension of cultivation and afforestation. Though much of it may be fragmented, there is a considerable area in sizeable blocks. Inspite of the increasing pressure of population, very little extension of cultivation to waste lands has taken place during the last fifty years.

Present Pattern of Land Use

The present pattern of Land use in India can be studied on the following lines : Forest areas not available for cultivation, fallows, other uncultivated land excluding fallows, and net area sown. The total geographical area of the country is 32.68 crore hectares. Land utilization statistics are available for 29.98 crore hectares or 91.8 per cent of the total area.

The following table XXXVIII gives details of land utilization in India for 1950-51 and 1962-63.

TABLE XXXVIII : *Land Utilization*

	In crore hectares	
	1950-51	1962-63
Total Geographical Area	32.63	32.68
Total reporting area	28.43	29.98
Forests	4.05	5.67
Not Available for cultivation		
(1) Land put to non-agricultural uses	1.12	1.47
(2) Barren and Uncultivable land	3.63	3.42
Total	4.75	4.89
Other Uncultivated land excluding Fallow lands—		
(1) Permanent Pastures and grazing lands	0.67	1.40
(2) Land under tree crops and groves	1.99	0.57
(3) Cultivable waste	2.29	1.74
Total	4.95	3.71
Fallow lands—		
(1) Current Fallows	1.07	1.06
(2) Others	1.74	1.03
Total	2.81	2.09
Net area sown	11.87	13.62
Area sown more than once	1.32	1.99
Total cropped area	13.19	15.61

Agricultural land

The first detailed consideration is that of land under cultivation. In the Indian Union this type of land varies from one state to another. In

(Figure 25 an attempt has been made to show the net cultivate area of each state out of their respective total area.

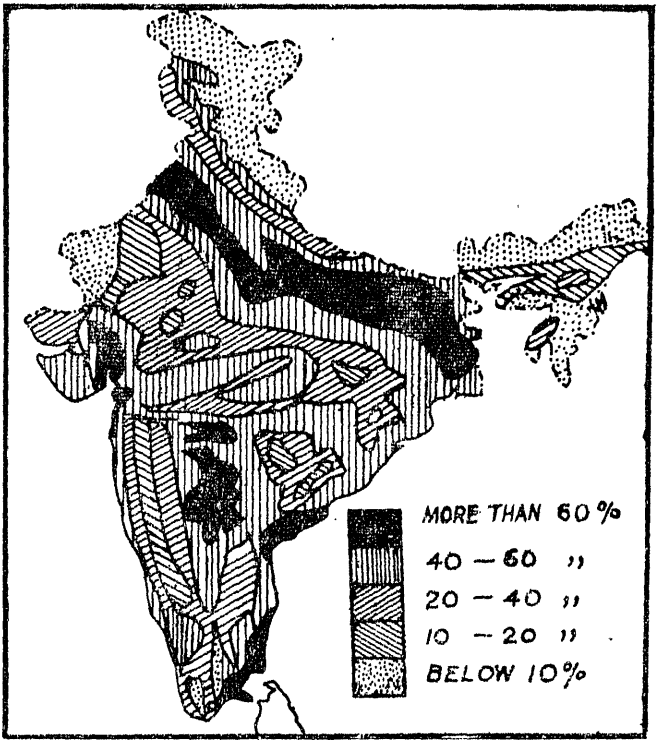


Fig. 25. Percentage of Cultivated Area.

It vividly illustrates that most of the rich cultivated areas in India is confined to northern plain and its adjoining region. The soil of the northern plain is usually a light loam or alluvium, and in many places even sandy. This zone is under continuous cultivation in Gangetic plain, its fertility being maintained by manuring with the droppings of cows, buffaloes, sheep and goats kept in the village. It is well known that cultivation in India virtually ceases at a certain elevation. Ploughed fields and fields of unimproved grassland give place to wide stretches of semi-natural vegetation.

The pattern of land utilization in India is thus conditioned by the following sets of factors :—

The main limiting factor in case of the Indian Union is deficiency of moisture. Rainfall in most parts of the Indian Union is concentrated

in a short period of three to six months. In the remaining months of the year, there is very little rain, and crops have to depend on moisture available from the sub-soil.

Secondly, the fertility levels of most of our crop-lands are low, because applications of farm-yard manure are generally inadequate and the use of chemical fertilizers has been practically non-existent. This is also an important reason for large areas being able to grow only one crop in the year.

The percentage of sown area to the total land area varies greatly in different parts of the Indian Union, depending mainly upon physical conditions of climate, topography and soils. The Gangetic plains and the coastal plains record the highest percentages, from 80 to 90, under cultivation. On the other hand, in mountainous or arid areas, the proportion of crop-land to the total may drop to 20 per cent or even lower. It will be seen from figure 25 that in the five states of the Indian Union, particularly in Bihar, Uttar Pradesh, Punjab, Madras and Andhra Pradesh, the proportions of sown area to the total vary between 50 and 60 per cent. In Madhya Pradesh, Gujarat, Orissa and Mysore, about 40 per cent of the land area is sown, in Assam the proportion is 20 per cent and in Rajasthan below 10 per cent. In the Northen districts situated in the northern mountainous region, the porportions of crop-land to the total vary generally between 20 and 30 per cent, and are much lower than in the Deccan. Comparisons with Northern and Southern regions are rendered somewhat difficult because of the existence of large areas of unclassified lands in these. But the acreages reported by Land Records office at Delhi under crops are quite low and generally range between 20 and 40 per cent of the land area. The Southern tableland have generally much higher proportions of lands under cultivation than the central and northern regions. Most of the central and northern regions have large areas of hilly, mountainous or dry lands. Thus in Kashmir, Assam and NEFA, these are located in the hilly sections covered by jungles and inhabited mostly by backward people. From this, it appears that most of the unclassified areas are either barren and unproductive or are suitable only for forests or grazing; the proportions suitable for cultivation are not large.

Area Not Available for Cultivation

This class includes land occupied by villages, towns, roads, paths and other non-agricultural uses, lands under beds of streams, rivers and other water bodies and barren lands in hilly or mountainous areas. This class includes on the one hand lands which are being used for highly productive purposes (some of these command very high prices also) and on the other those which are practically useless. This lumping together of very different kinds of lands is obviously very unsatisfactory.

The total area included in this class is 4.89 crore hectares. The percentages for Orissa are 12, Madras and Mysore 9 each and U.P. 15.

The largest barren areas exist in Assam (5.6 million hectares), Gujarat (3.6 million hectares), Madras (4.0 million hectares), Rajasthan (6.4 million hectares) and Uttar Pradesh (4.4 million hectares). Maharashtra with 2.4 m. hectares, Madras 2.0 m. hectares and Kerala with .32 million hectares have the lowest acreages under this class.

FALLOW LANDS

The Fallow land of India can be classified into two categories—

(a) Current fallow.

(b) Old fallow.

(a) *Current Fallow.* This division includes such land which is left fallow for two or three years after being cultivated for sometimes. The efficiency of this system in perserving fertility and maintaining crop yields has to be acknowledged. The vegetation which springs up during the three year's fallow is sometimes burnt and shometimes ploughed in.

It can be assumed that if fertility were not maintained at a reasonable level for the three to five years of cultivation then the period would be reduced in length. There was, however, evidence of a falling off in the condition of crops planted in the third and fifth year.This is due to the inevitable reduction in fertility but also to an apparent reduction in the care taken in cultivation. 1.06 crore hectares of land in India is under the current fallows.

(d) *Old Fallows.* Some of these lands have been cultivated in the recent past, for, as mentioned above, land under "current fallows" is brought under this class if it remains uncultivated beyond a specific period. But large areas may have remained uncultivated since long. Formerly, the term "culturable waste" was used for these lands, but this term had to be given up because it was realized that large areas were not fit for cultivation due to rough terrain, thin or eroded soils or for other reasons. Figures for areas suitable for cultivation within this class are reported for some states but not for others. The total area under this class is about 1.03 crore hectares.

Other Uncultivated land

3.71 crore hectares of land in India is under the heading "other uncultivated land excluding fallow lands". Of this, 1.74 crore comprise of culturable waste; 1.40 crore hectares of permanent pastures and grazing lands and the rest (0.57 crore hectares) is under tree crops and groves. Grazing takes place mostly in forests and other uncultivated lands (including current fallows) wherever pasturage is available. In most of the private forests, as also in forests managed by Panchayat and Gaun

Sabha, grazing is practically unrestricted. Even in the reserved forests of the Forest Departments in which grazing is regulated, it is allowed for a large part of the year.

The present problem of waste land is usually one of land which has been previously used but which has been abandoned and for which no further use has yet been found. It embraces land of various types.

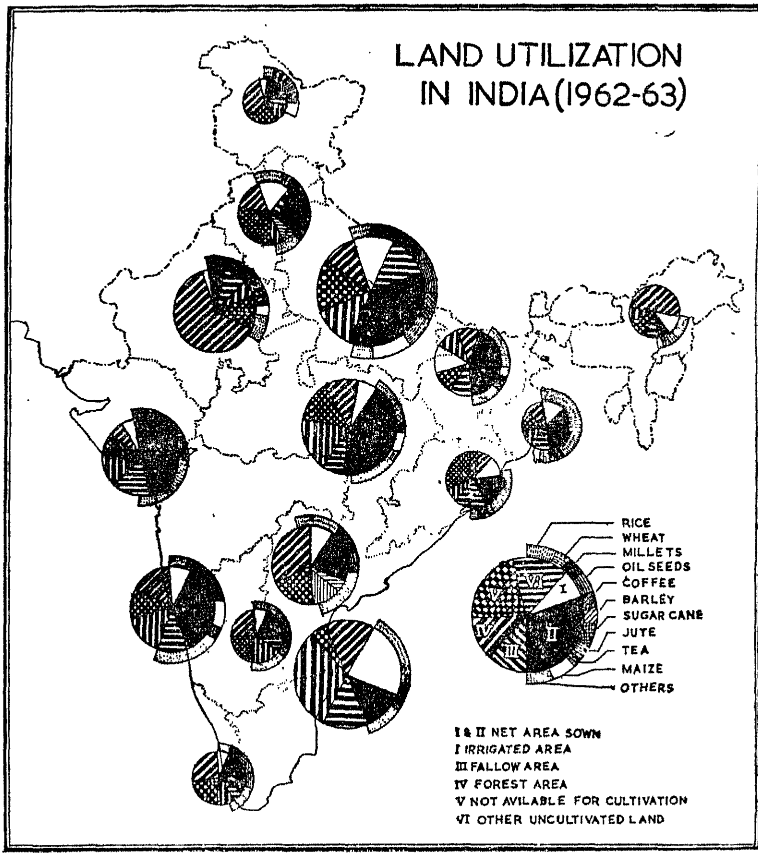


Fig. 26 Land Utilization in India

Forests

There are forests, covering an area of about 5.67 crore hectares. The forests in the Indian Union contain trees like Sissoo, Khair, Kanju, Sal, Semal, Chir, *etc*. Figure 26 shows the major land use categories in India.

The most dense and valuable forests in the Indian Union are those of Terai and Bhabar. With the gradual exploitation of these forests for commercial purpose, there set in a stream of people from the densely populated and highly pressured land areas, who ultimately settlea there. New settlements of people came into being as the density of population in the Indian Union increased upon the agricultural land. After the second World War and partition of India many refugees settled in these areas. The yield per acre of land had been very good at first but with the lapse of time the yield of land went on deteriorating as a result of the lessened fertility of the soil. The decreasei n the agricultural yield resulted in the expansion of agriculture to other areas.

Possibilities of increasing the area under cultivation

At this point, when the various classes of land have been considered, it is possible to discuss the question of possibilities of increasing the area under cultivation. The question is of considerable significance as increasing the cultivated area is one of the two major means (the other being increase in productivity per acre) of raising agricultural production. Unfortunately, however, in the existing state of information of land utilization it is not possible to make any definite statement on this subject. The available statistics do not cover the whole area of the Indian Union, and the classification is not sufficiently detailed to bring out all the information that is required.

As for forests, there is undoubtedly scope for extending cultivation to a limited extent in forest areas in some parts. But against this, there are much larger areas of cultivated land which should be retired from cultivation and brought under forests in order to afford protection from soil erosion, desiccation, *etc*. The net result would most probably be a decrease in cultivated area and not an increase. The area under forests is insufficient and has to be increased.

Certain pasture lands are being broken and some forest lands cleared for crops, while other hilly or sandy lands, formerly used for crops, are being allowed to revert to pasture or forest. Some people are leaving the land and moving to the cities, while others are taking their places on the land.

The main conclusion which emerges from the above analysis of the pattern of land utilization in India is that with our present methods of land use the available area is very insufficient for our needs. Even though as much as one-fifth of the land is under crops—a fairly high percentage in comparison with other country. And as most of it is of low productivity, agricultural production is not adequate to meet our needs even at the present very low standard of consumption. For example, although 90% of the crop-land under food-

grains, production of food grains falls short of consumption by 7,462 thousand tons.

While the population has increased by about 39 per cent during the last five decades, the production of foodgrains has not kept pace with it. This indicates an appreciable decrease in per capita availability of foodgrains from internal sources. For more than three decades India has been getting a much larger quantity of grains (mainly rice) from Burma than what it was exporting to other countries. The separation of Burma in 1936 has reduced internal supplies by about 1.3 million tons, and the partition in 1947 by a further 0.77 million tons. Since 1948 we have been importing large quantities of foodgrains, 2.8 million tons in 1948, 3.7 million tons in 1949, 2.1 million tons in 1950, and 47 million tons in 1951. The following table XXXIX shows the import of cereals into India in 1956 and during 1961 to 1965.

TABLE XXXIX *Import of Cereals.* (in thousand tons).

Year	Rice	Wheat and wheat flour	Other cereals	Total cereals
1956	3.30	11.13	—	14.43
1961	3.84	30.92	19	34.99
1962	3.90	32·50	—	36.40
1963	4.83	40.73	—	45.56
1964	6.45	56.21	—	62.66
1965	7.83	65.83	96	74.62

Agricultural production in India can be increased along two directions—

(i) Increased yield from existing fields,

(ii) Cultivation of new lands.

(i) Increased yield from existing fields is possible only at a great expense of money. Intensive use of natural and artificial manures alone can considerably increase the yield from the soil. The money necessary for buying artificial manures, mostly from foreign countries, is lacking in India. The Indian farmer is too poor to afford this. This factory at Sindri produces about 3½ lakh tons of ammonium sulphate annually. But the total requirements of this manure for this country have been estimated at 15 lakh tons annually. The use of natural manure can be increased slightly by a change of habits. At present cow-dung is used partly as domestic fuel. This practice can be changed by using soft coke as a domestic fuel. It is not, however, easy to change overnight the habits of the people formed during centuries. The Government is making efforts to convert into manure other kinds of refuse as well.

Night soil and cow-dung and farm refuse generally are being made into "Compost". In 1949-50 about 10 lakh tons of compost were made in urban areas by the municipalities. About 50 lakh tons of compost was made by the villages. In 1958-59, 26.4 lakh tons of compost manure was prepared from refuse materials as compared with 22.2 lakh tons in 1957-58 and 18.8 lakh tons in 1954-55, 18.3 lakh tons in 1956-57. A number of new schemes have been prepared for the utilization of compost and it is estimated that these will give 14 million gallons of manurial water per day, irrigate about 5,600 hectares and yield about 14,000 tons of additional production of foodgrains and vegetables. Thus the supplies of manure are being increased in India. Mechanisation of agriculture has also been recommended for increasing food supplies in India.

It has been pointed out that about 730 lakh Indians produce crops from their agricultural land only as much food as about 70 lakh Americans do from theirs. The advantage of the Americans is said to be due to the farm machinery used in America. To modernise Indian agriculture, therefore, the Government of India has started a Central Tractor Organisation which possesses a fleet of tractors, agricultural implements and additional machinery. These tractors are working in different states of India helping the farmer to produce more from his land. The use of tractors is becoming popular in India since the Second World War. This will be clear from the increasing imports of tractors in the country. During 1948-49 we imported tractors to the value of Rs. 1.9 crores and this value increased to Rs. 7.8 in 1951-52. However, in 1954-55 we imported tractors to the value of Rs. 3.9 crores. There are about 45,000 tractors in use in the country today. During 1958, the C.T.O. reclaimed 15,600 hectares of kans land and 1,200 hectares of jungle land, besides carrying out levelling and terracing over an area of 1600 hectares, bringing the progressive total of area reclaimed by it since its inception to 6.6 lakh hectares.

An increase in the yield is also possible by using improved seed and better tillage with improved agricultural implements. Increased irrigation will also help. Under rabi campaign, supplies of wheat seed and paddy seed were made available for M. P., Bengal, Rajasthan and Bihar.

Efforts are being made by the Indian Council of Agricultural Research to bring 8.8 million hectares of land in the famine zone of India under improved cultivation by dry farming. A comprehensive scheme of research in dry farming was formulated by this council in 1930. But it was not until 1933 that funds were available for this purpose, and experimental stations were started in the statses of Bombay, Madras, Hyderabad and the Punjab. The results obtained at Sholapur and Bijapur showed that the average grain yield under the improved method

after five years was about 90% higher than the one obtained by old methods.

(ii) Most of the suitable land for agriculture has already been occupied. There is, therefore, very little scope for finding new land for agriculture. The only areas where new land is available are the semi-deserts in the Rajasthan where the soil is fertile, but where cultivation is not carried on at present for want of irrigation facilities. Gradually as these facilities are extended, some land will become available for agriculture. This is the only important source of increased agricultural production in India.

Besides, the Malnad, *i.e.*, the country in south between the Ghats and the Sea-coast from Goa to Cannanore can also be made to yield crops. In spite of the great geographical advantages like the fertility of the soil and the heavy rainfall Malnad is at present in a backward position because of excessive rainfall, unhealthy climate, prevalence of malaria, inadequacy of communication and scarcity of labour. If these problems are solved, Malnad can contribute substantially towards the production of foodgrains in the country.

Further, at present we have several million hectares of cultivable wasteland infested by mosquitoes and malaria such as in sub-Himalayan Terai, along Western and Eastern Ghats. In these areas rice cultivation may be profitably undertaken as the rainfall is between 125 cms. and 250 cms. per year.

The population of India is increasing at a considerable speed, but the area under food crops is either steady or decreasing owing to a part of it being transferred to the important commercial crops. The problem of food supply is, therefore, becoming acute every day.

The total population of India in 1951 was about 357 millions, which was 439 millions in 1961. The population of India is increasing every year by about 1 per cent. Every year there are about 50 lakh fresh months to be fed. The shortage of food must, therefore, be offset by the increase in cereal output. The following table gives a comparision with U. S. A. and U. K.—

	India	U.S.A.	U.K.
Per capita consumption (in calories) per day	1,683	3088	3068
Food Contents (per cent)—			
Cereals	68.0	23.0	30.0
Pulses	12.0	2.6	1.7
Nutritional elements in daily diet (per cent)			
Fats and oils	4.0	15.0	16.0
Fish	3.0	21.0	27.0
Milk	6.0	13.0	11.0

Deficiency in Indian Food

	Nutritional Standard requirements (in ounces)	Quantity now being consumed (in ounces)
Average daily diet of which—	48.0	18.0
Ghee and oil	2.0	0.3
Milk and Milk products	10.0	5.0
Fish and other proteins	4.0	0.3

Solution of food problem

(1) Changing the habits of the people, so that more meat and fish may be included in the diet of the people.

(2) Better exploitation of Indian fisheries. The fisheries of India have been neglected so far. The backward condition of Indian fisheries is due to several factors such as lack of mechanised fishing, poor organization and management of the fish trade, the conservative nature of the fisherman, inadequate transport facilities and the unhealthy influence of the middle men.

(3) Changing agricultural practices so that more fodder could be grown for cattle or goats which could supply meat or milk. Root crops and lucern can be grown in larger quantities as rotational crops, leading to soil fertility and greater supply of cattle fodder. Increased meat and milk supply can then take the place of cereals raised for our food from the soil. In order to bring about this change, however, better facilities for irrigation will have to be provided.

(4) More manuring of the soil to enable greater yields of crops.

(5) Scientific improvement in our agriculture to enable better yields, or reclamation of lands at present lying barren.

(6) Bringing new areas under cultivation by extending irrigation facilities and clearing forests where necessary.

(7) Restriction of the area under certain commercial crops like cotton and jute whose market is mostly outside the country and where the competition has become now serious.

Food Problem Short-term Emergency Measures

Short-term measures taken to minimise the dependence of the country on import of foodgrains fall into two categories, namely, measures to increase food production and measures to utilise the foodgrains produced in the country in a judicious manner so as to meet the maximum possible demand with these foodgrains.

The measures to increase production of foodgrains were :

(1) Introduction of minor irrigation schemes like construction and repair of wells, tanks, channels, small dams, tubewells etc.

(2) distribution of chemical fertilizers and other manures amongst the cultivators;

(3) distribution of improved seeds;

(4) fisheries development scheme;

(5) land improvement schemes like contour bunding, clearance and reclamation of waste lands, etc.

(6) plant protection and anti-plant disease schemes;

(7) other grow-more schemes intended to increase the yield per acre; and

(8) Special campaign now being organised to increase the production of rabi grains, *viz.*, wheat, barley, gram and rabi jowar, by concerted action in educating the farmers in improved method of farming, arranging timely supply of improved seeds, fertilizers, manures, etc., securing co-operation of village workers and farmers and infusing enthusiasm in them to increase the per acre yield of food grains.

In the 3rd Five year Plan greatest stress was laid on food production but as a matter of fact little attention could be paid resulting in excessive low production over the past years. We were importing foodgrains worth about Rs. 1.50 crores every year. This resulted in increase of prices and cost of living. It was therefore thought fruitful to plan an "emergency Food Production" laying greater stress on food production during the entire period of the 3rd Plan. It has been further recommended to accord credit facilities and proper arrangement of irrigation and manure. Further, it is intended to increase the irrigation area. This includes programmes for soil conservation, dry farming, land reclamation flood control, improve seeds and agricultural implements, use of manures and fertilizers etc.

QUESTIONS

1. "The physiographic units of India afford the most appropriate framework for any scheme of land utilization". Discuss. (*Agra*, 1951.).

2. Discuss in detail, with reference to Indian Union, the possibility of constructing, on information at present available, a "potential land use" map.

3. Give an account of the influence of structure, land forms and climate on habitability and the utilization of land in Peninsular India. (*Agra*, 1954)

4. Discuss the influence of physical and climatic conditions on population and land utilization in either Kerala or the vale of Kashmir. (*Agra*, 1957).

CHAPTER 10

Agricultural Problems and Distribution of Crops

A nation, in order to feed its population and to provide the raw materials to meet its other requirements, has to depend mainly on its soil resources and agricultural productions. Just as human beings and animals have certain requirements for their well-being, plants also have their requirements which are met out from the natural resources. Of course, many factors are involved in proper utilization of the resources to produce the best effect. If any of these become a limiting factor, crop production is markedly affected. These complex factors can be mainly grouped into two heads—climatic factors and soil factors.

Physical and chemical properties of soils and meteorological conditions control and determine the distribution and cultivation of food crops. In the Indian Republic, where the rainfall is extremely variable and uncertain; agricultural security cannot be achieved and it is the geographical environment which determines the high or low agricultural productivity of the different states by determining the geographical distribution of crops. Every crop has its own particular range of environment. It finds the most favourable environment in a particular region, and in such a region a comparatively large area sown under this crop, as well as its high yield, shows that it is an important crop characteristic of that region.

Before studying the main crops grown in India, it is quite necessary to study the practices usually associated with the agriculture in India.

Fragmentation of Holdings

After the father dies, his land is distributed amongst the sons. This distribution of land does not entail a collection or consolidated one, but its nature is fragmented. This is due to the fact that tracts vary in fertility. If there are six tracts which are to be distributed among three sons, all or them will get smaller plots of each land tract, and in this way the inheritance of land goes on and with the fragmentation of land holdings becomes more acute. The important cause of the low productivity of land and of the backwardness of agriculture all round is to be found in the excessive subdivision and fragmentation of holdings in many parts of the country.

Sub-division and fragmentation have made cultivation more costly. This practice is very wasteful, in the sense that the farmer can-

not concentrate all his attention and energies at one particular place. According to Turner, "The disadvantages are obvious. The nearer fields are apt to be over worked and the remote ones neglected. It involves waste of labour in moving manure, implements, cattle and water to a distance, waste of land in providing boundaries and waste of time in going to and fro between the fields. It facilitates damage by theft and cattle trespass; makes the use of labour saving difficult; and it restrains cultivators from attempting improvements." He cannot provide proper manuring to the fields. No irrigation is possible in such fragmented holdings. Sometimes it leads to litigation and wastes the farmers hard-earned money. No preventive measures can be taken against the pests and locust menace. The only solution of this problem is the consolidation of holdings. This can be done through co-operative societies. But the Indian farmer is a great ancestor—worshipper. He cannot abandon the land inherited to him by his forefathers. So the final solution is the enactment of legislation. A certain limit should be fixed by the government beyond which no fragmentation should take place.

Manure

Agriculture in India does not get proper manures. The soil of India is being exhausted largely owing to lack of manure. According to Basu the fertility of the soil being reduced fast to the permanent limit by (1) Continued cultivation without replacement by sufficient manure, (2) Spread of cultivation, (3) Cattle epidemics. The supply of manure is extremely limited.

Manure and fertilisers play the same part in relation of the soil as food in relation to the body. Just as a well-nourished body is capable of the maximum effort, a well nourished soil will have the best fertility. Manures may be classified into two classes—(a) organic and (b) inorganic manures. Organic manures may further be sub-divided into (i) bulky organic manures (ii) concentrated organic manures. Bulky organic manures include far-myard manure, compost manure, nightsoil and green manure, while concentrated manures are oil cakes, bonemeal, dried blood, horns and hoofs, etc. The addition of bulky organic manures like farmyard manure, which is a by-product in farming by bullocks, helps the soil by increasing its water holding capacity, improving soil aeration, and by changing the plant nutrients through slow decomposition into forms readily available to plants. There are other advantages in the use of organic manures namely,

(a) Steadiness in yield over a period of time (b) benefit to the succeeding crops by their residual effects, and (c) ability to withstand unfavourable weather conditions.

On the basis of the 1951 livestock census the total production of fresh dung is estimated at 800 million tons; however, all this

valuable manure does not go back to the land. A large part of it—which may amount to nearly 50 per cent—is used as fuel by cultivators.

The above estimates do not relate to cattle urine which is rich in nitrogen but mostly goes to waste.

Coming now to inorganic or synthetic fertilizers. Table XL give the consumption of major fertilisers nutrients in each state in India. It would be seen that ndhra Pradesh, Kerala and Madras use the highest amounts (7-10 lb. of fertilizers, N + P_2O_5 + K_2 O), while Rajasthan, Madhya Pradesh, Orissa and Assam use the smallest amounts of fertiliser nutrients (less than XL one pound per acre).

TABLE XL : *Consumption of Fertilisers Per Unit Area of Agricultural Land, by States, in India,* 1962-'63.

State	Consumption in Kg. per hectare.			
	N	P_2O_5	K_2O	Total
Andhra Pradesh	6.77	1.79	0.04	8.60
Assam	0.11	0.08	0.12	0.31
Bihar	2.02	0.31	0.11	2.44
Gujarat and Maharashtra	1.49	0.66	0.10	2.25
J. & K.	1.33	0.01	—	1.34
Kerala	3.94	0.84	4.60	9.38
Madhya Pradesh	0.64	0.16	—	0.85
Madras	8.64	1.16	1.17	10.97
Mysore	2.06	0.60	0.40	3.06
Orissa	0.81	0.15	0.02	0.98
Punjab	3.21	0.24	0.01	3.37
Rajasthan	0.39	0.09	—	0.48
U. P.	2.02	0.19	—	2.21
West Bengal	1.95	0.85	0.53	3.33
Delhi	2.58	0.16	—	2.74
Himachal Pradesh	0.25	0.23	—	0.48
Manipur	0.20	0.10	—	0.30
Tripura	0.48	—	—	0.48
Andaman & Nicobar	0.03	—	—	0.03
Total for India	2.51	0.55	0.22	3.28

The Planning Commission of India with the advice of Indian Soil Scientists has fully appreciated the needs of soils and crops for balanced

fertilization. This is reflected in the production and consumption targets for the Third Five Year Plan in table XXXXI.

TABLE XXXXI : *Targets of Production and Consumption of Nitrogen, Phosphorus, and Potassium Fertilisers in India during the Third Five Year Plan.* (Thousand metric tons)

Year	Production			Consumption		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
1961-62	140	100	—	400	100	82
1962-63	200	150	—	525	150	100
1963-64	300	225	—	650	225	130
1964-65	500	300	—	800	300	160
1965-66	800	400	—	1000	400	200

The use of nitrogenous fertilisers has been increasing steadily but it has not been possible to meet the full requirements on account of inadequate internal production and shortage of foreign exchange. In 1964-65, the consumption of nitrogenous fertilisers amounted to 5.43 lakh tornes (N) while in 1965-66 the level of consumption expected to be reached was estimated at 6 lakh tons (*N*). The consumption of phos phatic fertilisers was 1.50 lakh tons (P_2O_5) in 1964-65 and was estimated to be of the same order in 1965-66, owing to shortage of imported raw materials.

Soil Erosion

The soil exhaustion in India is not merely a question of limiting plant food, it is the position of that plant food in the soil. In most places manuring is beyond the financial scope of the farmer. Continued manuring year after year is the exception rather than the rule, and therefore, most of the mauures applied must be looked upon as a top dressing. The result is that there is a tendency for crops to feed near the surface which greatly affects their power of resisting drought. If a crop is to resist drought, plant food must find its way deeper into the soil where the roots of the crop should normally develop, and this can now only be done by regular and systematic manuring.

Soil erosion is the most serious problem facing the agriculture in India. The effect of soil erosion is far fetched upon agriculture. This goes far beyond the removal of the valuable top soil on which plants depend for their nourishment. One direct effect is of course gradual decline in crop yields which more than offsets any gains brought about by seed selection and manuring. The direct effect in pastures and grazing lands is to reduce the capacity of land for carrying livestock. sceds.

Agriculture in India, moreover, suffers from the application of inadequate and bad seeds. Usually seeds are laid aside and kept unprotected for the next sowing season. Thus the seed is badly affected by the worms and when sown the resulting plants also turn unhealthy. Sometimes, the farmers have to open their seed-store for consumption and for sowing purpose borrow it from the local grain merchants or Baniya which is bad and unhealthy.

The best solution of this problem is the inauguration of co-operative seed-stores which will provide the farmers large grained and healthy seeds. Cooperation on the ordinary pattern may be difficult to introduce because people are illiterate and do not underst.and a money economy.

Indebtedness of Cultivators

In India, the natural indebtedness of the cultivating classes,and their recklessness in the matter of marriage expenditure and in litigation, are features which affect most seriously the possibility of improving the agriculture. Owing to the pressure of population and the special tendency to litigation and to spending large sums on marriage, the nation is loaded with a large burden of debt.

The smallness of the holdings occupied by cultivators constitutes a limit to the possibility of improvement. The average size of a holding is probably below four acres, and each man's first concern is to provide food grains for himself and his family. Consequently it often happens that land which might grow highly remunerative crops is given up to the growing of grain crops and the best use of it is accordingly not made. The land is often handed over to poor tenants who cannot wait for rich crops like Sugar cane and Tobacco, but much grow food grains. Other influencing circumstances are the varying systems of land tenures, the relations of tenant to land-holder and of people to the nation, the indebtedness of cultivators, the want of capital in agriculture, and the subdivision of land. The poverty and indebtedness of the average farmer makes it impossible for him to improve his farming by any means requiring capital. In addition he has little incentive to do so, as his margin between success and failure is so small that he dare not try any new ideas.

All the above factors contribute a lot towards lowering the yield per hectare. The yield in India is lowest in the world. In India the average productivity per man per year in agriculture is the lowest as would be clear from the following data :—

Country	(in U. S. Dollars)
W. Germany	3,495
New Zealand	3,481
Australia	2,442

U. S. A.	2,408
Japan	2,265
Canada	2,126
U. K.	2,057
Austria	1,233
Norway	973
India	105

Crop Pattern

After studying the Agricultural practices and the problem associated with it, the study of the crops is also quite essential. The crops grown in India can be classified into two heads—

(1) Subsistence crops which includes Wheat, Rice, Jowar, Bajra, etc.

(2) Commercial crops such as Sugar-cane, Tobacco, Tea etc.

Relative Importance of Major Crops

The two outstanding features of agricultural production in India are the wide variety of crops and the preponderance of food over non-food crops. The table xxxxII below shows the area under major crops in 1950-51, 1955-56, 1960-61 and 1964-65.

TABLE XXXXII : *Area Under Principal Crops*

(in thousand hectares)

Crop	1950-51	1955-56	1960-61	1964-65
Rice	3,08,10	3,15,21	3,41,28	3,60,77
Jowar	1,55,71	1,73,62	1,84,12	1,80,12
Bajra	90,23	1,13,38	1,14,69	1,17,12
Maize	31,59	36,96	44,07	45,91
Ragi	22,03	23,07	25,15	24,29
Small millets	46,05	53,35	49,55	45,55
Wheat	97,46	1,23,67	1,29,27	1,34,53
Barley	31,13	34,18	32,05	26,68
Total cereals	7,82,30	8,73,44	9,20,18	9,34,97
Gram	75,70	97,79	92,76	90,11
Tur	21,81	22,87	24,33	24,73
Other Pulses	93,40	1,11,50	1,18,54	1,25,02
Total Foodgrains	9,73,21	11,05,60	11,55,81	11,74,83
Potatoes	240	280	375	417
Sugar cane	1707	1847	2415	25,44
Black pepper	80	89	103	103
Chillies	592	604	667	714
Ginger	17	16	19	22

Tobacco	357	410	401	423
Ground nut	4494	5133	6443	7072
Castor Seed	555	574	466	449
Sesamum	2204	22,93	2169	2503
Rape & Mustard	2071	25,29	2883	2814
Linseed	1403	15,29	1789	2011
Cotton	5882	80,86	7610	8154
Jute	571	704	629	841
Mesta	N. A.	231	274	359
Tea	314	316	231	N.A.
Coffee	91	101	114	N.A.
Rubber	58	70	129	N.A.
Coconut	622	647	717	N.A.

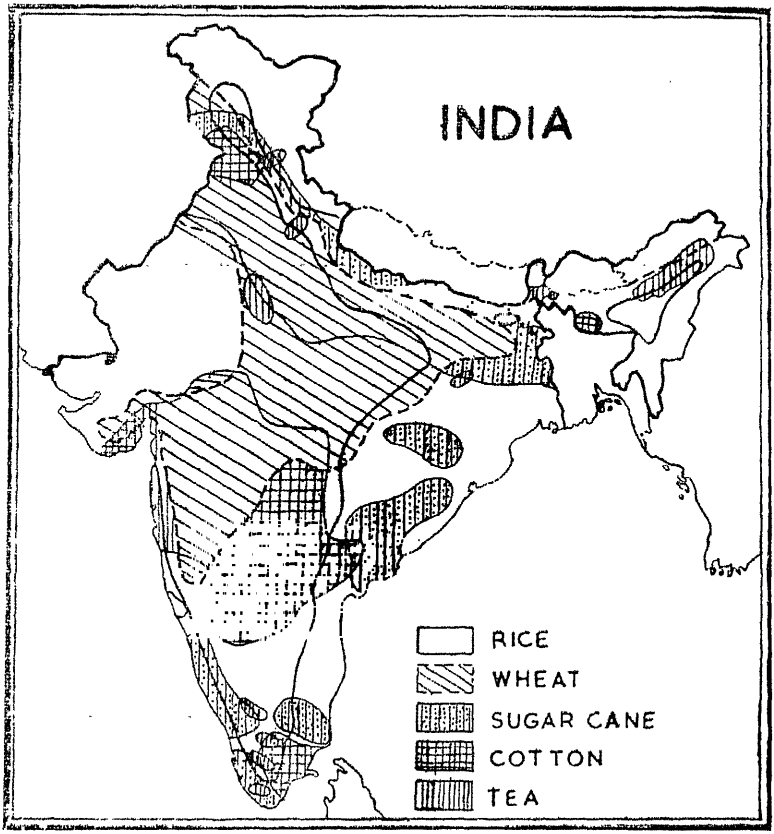


Fig. 27. Distribution of Rabi Crops.

The subsistence crops grown in India can be further sub-divided into two heads—

(i) Rabi crops
(ii) Kharif crops

The major rabi crops are wheat, barley, gram, linseed, rape and mustard. The major kharif crops are rice, jowar, bajra, maize, cotton, sugarcane, sesamum and groundnut. See fig. 27.

The seasons and duration of principal crops are shown below—

Crop seasons.

Crop	Season	Duration	
Rice	Winter	$5\frac{1}{2}$ to 6 months	
	Autumn	$4—4\frac{1}{2}$	,,
	Summer	2—3	,,
Wheat	Rabi	$5—5\frac{1}{2}$	,,
Jowar	Kharif	$4\frac{1}{2}—5$	,,
	Zaid Kharif	$2\frac{1}{2}$	,,
Bajra	Kharif	$4\frac{1}{2}$	,,
Maize	Kharif	$4—4\frac{1}{2}$	,,
Ragi	Kharif	$3\frac{1}{2}$	,,
Barley	Rabi	$5—5\frac{1}{2}$	,,
Gram	Rabi	6	,,
Sugarcane	Perennial	10—12	,,
Sesamum	Kharif	$3\frac{1}{2}—4$	,,
	Rabi	5	,,
Groundnut	Kharif Early Late	$4—4\frac{1}{2}$	,,
Rape & Mustard	Rabi	4—5	,,
	Zaid Rabi	4	,,
Linseed	Rabi	$5—5\frac{1}{2}$	,,
Castor	Kharif Early Others	8	,,
Cotton	Kharif Early Late	6—7	,,
Tobacco	Kharif	7	,,
Jute	Kharif	6—7	,,

Agriculture is the most important industry of the people in India. Leaving out China, there is no country in the world in which so many people depend on agriculture for their livelihood as in India. About 70% of our total population is engaged in this industry. Yet, in spite

of it, the present-day agriculture in India cannot be said to be a scientific agriculture. It ranks first in the World in the production of ground nuts and tea and enjoys a virtual monopoly in production of lac. It is the second largest producer of rice, Jute, raw Sugar, rape seed, sesamum and castor seed. Table XXXXIII shows the production of principal crops during 1950-51, 1955-56, 1960-61 and 1964-65.

TABLE XXXXIII : *Production of Principal Crops*

Crop	1950-51	1955-56 '000 tons	1960-61	1964-65
Rice (cleaned)	205,76	2,75,57	3,45,74	3,87,32
Jowar	54,95	67,26	98,14	98,11
Bajra	25,95	34,28	32,83	44,65
Maize	17,29	26,02	40,80	45,58
Ragi	14,29	18,46	18,38	19,21
Small millets	17,50	20,70	19,09	19,77
Wheat	64,62	87,60	109,97	1,20,78
Barley	23,78	28,16	28,19	24,78
Total cereals	4,24,14	5,58,05	6,93,14	7,60,20
Gram	36,51	54,18	62,50	57,63
Tur	17,19	18,61	20,66	18,94
Other Pulses	30,41	37,66	43,88	47,21
Total Foodgrains	50825	6,68,50	8,20,18	8,83,98
Potatoes	1660	18,59	27,19	34,52
Sugarcane	5,70,51	6,05,43	10,89,73	12,21,27
Black pepper	21	28	28	24
Chillies (dry)	351	361	419	455
Ginger (dry)	15	16	18	21
Tobacco	261	303	307	370
Ground nut (nuts in Shell)	34,81	38,62	4812	61,76
Castor Seed	103	125	107	101
Sesamum	4,45	467	318	466
Rape & Mustard	762	860	1347	175
Linseed	267	420	398	466
Cotton (lint)	2875[1]	3949	5293	54,08
Jute (dry fibre)	3309	4232	4134	60,79

[1] 1000 bales of 180 kgs. each.

Mesta (dry fibre)	N.A.	11,62	11,29	15,89
Tea	275	285	321	N.A.
Coffee	25	34	43	N.A.
Rubber	14	23	25	N.A.
Coconut	358[1]	423	464	N.A..

Most of the cultivated area lies in the plains of the Ganga and the Sutlej and the coastal plains. More than one-half the area of these plains is under the plough. The remaining part of the cultivated area lies scattered in the plateau region where the black soil region is the most important. An important feature of the plateau region is the large proportion of cultivable area left as fallow. Andhra Pradesh, Madras, Maharashtra and Gujarat, Rajasthan and Madhya Pradesh showed the largest area of fallow land. More than half the fallow land of India lay in these States. A cretain part of the agricultural area in India is cropped more than once in the year. See table xxxxv below.

TABLE XXXXV : *Area sown under all Crrops*

(thousand hectares 1962-63)

State	Net Area Sown	Area sown more than once	Total Area Sown
Andhra Pradesh	11509.6	1184.0	12693.6
Assam	2304.0	413.6	2717.6
Bengal	5372.8	907.6	6280.4
Bihar	8247.2	2706.4	10952.4
Gujarat	9454.4	557.2	10010.0
J. & K.	680.8	138.4	819.2
Kerala	1986.0	432.4	2418.4
M. P.	16164.0	2029.6	16193.6
Madras	5947.2	1238.4	7185.6
Maharashtra	16203.6	940.4	17544.0
Mysore	10276.0	360.8	10636.8
Orissa	5844.8	474.4	6389.2
Punjab	7496.4	2417.2	9913.6
Rajasthan	13461.2	1000.4	14661.6

1 Crore nuts.

U. P.	17004.0	4641.6	21709.6
Delhi	86.4	22.4	68.8
Himachal Pra.	272.4	165.2	437.6
Manipur	164.0	4.4	148.4
Tripura	224.4	39.2	263.6
Andaman & Nicobar	9.2	.4	9.6
Laccadive & Minicoy	2.8	—	2.8
Total	134643.6	19674.0	154317.6

Agriculture in India is characterised by certain features which are not met within the agriculture of the industrialised countries of the west. There the requirements of factory workers dominate agricultural production. The features of Indian agriculture are—

(1) Most of the land in India is devoted to the cultivation of foodgrains. About four fifths of the cultivated area here is under food crops.

(2) There is no crop which is grown for the specific purpose of providing fodder for cattle or other animals. Cattle fodder in India is largely a by-product of the food crops.

(3) The use of manures is very scanty and haphazard. Most of the animal refuse which gives the best all-round manure, is burnt as fuel, owing to the scarcity of forests in the important agricultural areas here.

(4) The yield per acre, therefore, is very small.

(5) The Indian bullocks on whom falls the whole of the agricultural work are weak and puny creatures who cannot pull big ploughs necessary for deep ploughing.

(6) As contrasted with the temperate land agriculture, Indian fields generally produce more than one crop in the year.

(7) Severe losses occur in Indian agriculture owing to droughts, as the irrigation facilities are inadequate.

QUESTIONS

1. Analyse the present position of agriculture in India, and suggest ways and means which, in your opinion, will help its future development. (*Agra* 1950)

2. Discuss the distribution of crops in relation to rainfall in India.

3. "The word of an average Indian farmer ends at his horizon with an eye on the sky for the monsoon and with his lands in the earth for food, man lives close to nature." Discuss this statement in the light of chief characteristics of Indian agriculture. (*Agra* 1953)

4. Analyse the geographical background for the backwardness of the Indian agriculture. In what directions: in your opinion, can it develop ?

CHAPTER 11

Rice

Rice is the most important food crop of India. Nearly three-fourths of the people in the country subsist on it.

The Rice Environment

Rice, though principally a tropical crop requiring high temperature and humidity for its growth, is cultivated both in the tropical and Sub-tropical zones extending from 40 S to 45°N. latitude. However, most of the rice lies between 70° to 140°E longitude. Rice predominantly is a monsoon crop where alone it finds most ideal conditions for its growth.

Rice cultivation in India extends from 8° to 25° N. latitude, and the crop is grown under widely varying conditions of rainfall, altitude and climate. There are rice grown at sea level in the river deltas, in areas even below sea level with protective embankments as in some parts of Kerala State, in 5 to 6 metre of water as the deep water rice in the States of Assam and West Bengal, and at altitudes of 915 to 1524 metres and even more as in Kashmir and the slopes of the Himalayas.

Climate, Surface and Soil. The rice crop requires high temperature and high humidity, with abundance of water during its life period.

The paddy plants require very hot and humid weather conditions. They require a temperature from 10 to 21°C, during the tempera- sowing period. At the harvesting time, when it ripens, the tures suitable vary from 37 to 38°C.

Among the environmental factors affecting rice production, water supply is most important. The rice crop requires large quantities of water. In the north-eastern region, comprising Assam, West Bengal, Orissa and South Bihar, where the rainfall is high rice ir a dominant crop, occupying more than 80 per cent. of the cultivated area. Going further South through the plateau region of the Peninsula, the rainfall decreases, and the rice crop is grown to the extent of 30 to 40 per cent. of the cultivates area, being concentrated in the east and west coastal areas of Andhra Pradesh, Madras and Kerala States. In northern and central India, rice is grown wherever rainfall conditions are favourable. In this region whenever the natural rainfall lacks, the water from local canals is resorted to and the water requirements are fulfilled.

In India rice is grown under diverse soil conditions. The soils most suited to the cultivation of the crop are heavy soils-clays or clay loams. Such soils, capable of holding water, are found under tank and canal irrigation conditions and river delta areas, and crops on these soils give high yields. The most important groups of soil under which the crop is grown in the country are the alluvial soils, red soils, laterite and black soils and also marshy soils. Large areas under the crop are found along the banks of rivers, as water rather than soil is the more important factor in deciding on the suitability of an area for growing the rice crop.

Besides this happy combination, the monsoon lands are densely populated areas with abundant supply of cheap labour. For it must be realised that rice cultivation is not suited to mechanical cultivation. It needs plenty of hand labour. But water is the limiting factor in the cultivation of rice in India. Mountain slopes have been terraced or marshes drained to make rice farms wherever water is enough for the needs of rice. Where rain-water is not enough for rice, but where rice must be cultivated for some reason or the other, irrigation has to be provided. In general, it can be said that rice needs plenty of heat, plenty of rain, plenty of labourers, and plenty of alluvium to give plenty of food for plenty of people. There is no other food which is so plentiful in India as rice, but the people who eat it are also plentiful and hence a shortage of rice in the country.

Upland and Lowland Rice

The rice crop in India can be divided into two categories :—

(1) *Upland Rice.* Which is sown without irrigation, in the months of March and April and becomes mature within 5½ to 6 months. Hence its harvesting takes place in September-October. This is a drought resisting type of rice. It is usually grown in the higher elevation and rugged topography. This rice crop, sown in the month of 'Chaitra' is known as "Olkheri" or "Rasoti" in the local dialect. This variety of rice totally depends on natural rains for its water requirements. This variety is the characteristic crop of the hilly and drier regions. Its use is also confined totally to local consumption.

(2) *Low Land Rice.* The second variety of rice grown in India requires a lot of irrigation during its sowing and harvesting period. This variety of seed is firstly sown in small seed-beds, entirely covered with water. When the plant becomes 10-12 cms. in height, it is transplanted from the seed beds to larger fields. The transplantation is done mainly by the women and men and this practice is referred to as "Ropai". This variety of rice reaches maturity within 4½ months, so the harvesting is done in October-November. In the marshy lands the seeds are thrown all over the field and no transplation is done.

Distribution of Rice

Rice is grown in almost all the States of India, but its cultivation is mostly concentrated in the river valleys, deltas and low-lying coastal areas of north-eastern and southern India, in the States of Andhra Pradesh, Assam, Bihar, Maharashtra, Kerala, Madhya Pradesh, Madras, Mysore, Orissa, U. P., and West Bengal, which together contribute about 97% of the country's rice production.

Rice Regions

The rice areas in the country can be broadly divided into the following five regions according to the rice-cropping seasons.

1. *North-eastern Region.* This area, which comprises Assam, West Bengal, South Bihar and Orissa, grows rice in the basins of the Brahmaputra, Ganga and Mahanadi rivers, and has the highest intensity of the rice cultivation in the country.

Bengal is the largest producer of rice in India. Almost in every district rice accounts for more than 60% of the sown area. Most of this rice is obtained from the *AMAN* crop which is sown in June and harvested about November. It will be seen from the following table that during this period copious rain falls regularly in Bengal :—

Rainfall and Temperature in Bengal

Months	April	May	June	July	August	September
Rain (Centimetres)	8.4	19.3	36.8	37.8	35.5	27.1
Temperature	28.6	28.9	28.9	28.3	28.3	28.3

Bengal provides another requirement of rice cultivation in its uniformly high temperatures. But a high temperature is not so essential as high rainfall. For rice is cultivated on the slopes of the Himalayas even on heights of 8,000 feet (2438 metres) or so above sea-level where temperatures are not high.

The three main crops of Bengal and the neighbouring areas are given in the following table :—

Rice Crops of Bengal

Crop	When sown	When transplanted	When harvested
1. Aus	April-May	Sown (Broadcast)	August-September
2. Aman	June	July-August	November-January
3. Boro	October	December	March

When rice is cultivated on high lands or on dry lands which are not completely submerged during the rains, it is sown broadcast in the

field itself. But when it is cultivated in lowlands which are filled with water during the rainy season, it is first sown in nurseries from where the plants are transplanted into the fields when they are about a foot high.

In those lowlands where the water is too deep for transplantation of rice plants, a special crop of rice is sown broadcast in February or March before the rainy season starts. This crop is harvested only after the water has subsided in the field after rains.

(1) AUS or *autumn rice* crop. This is sown in April or May on comparatively high land and harvested in August or September. AUS paddy cannot be grown on land on which more than two reet of water accumulates during the rainy season. The land on which this paddy is grown is generally light and easily workable.

(2) AMAN *or winter rice* crop is sown from May to June and harvested from November to January. It faces complete submergence and the uprooting action of rushing water. It increases in height with the rise in water level.

Aman rice is the most important in Bengal. More than three-fourths of the rice acreage and output is accounted for by it. The following table shows the share of each crop :—

Crop	Acreage %	Output %
Aman	86	87
Aus	13	10
Boro	1	3

(3) BORO *or summer rice crop.* It is sown in depressions and swamps from October onwards when the rain water has subsided and is reaped in March. It grows in dry season and has to face droughts during the latter period of its growth when the water in the depressions is drying up. The yield per acre of this rice is the highest.

The rice crop in Bengal, and in other areas where irrigation is not much practised, is damaged to some extent by the vagaries of rainfall. The rice crop of Bengal is also sometimes damaged by untimely floods in the Ganga due to late and heavy rainfall in U. P. These floods fill the depression along the river with water which cannot be used for sowing the rice crop, as the water does not dry up in time for sowing.

Rice cultivation in Bengal is done almost without any manuring of the fields. It is only recently that green manuring is being advocated. Fortunately, however, large parts of Bengal are subjected to river floods resulting in considerable deposits of silt which help the land to regain fertility. To save the cultivator from loss, the Agriculture Department has developed by research early-maturing varieties, as also high-yielding varieties. Among the improved varieties, may be mentioned the "Dhoiral" of Bengal which yields up to 1200 kilograms per acre (2,560 lbs.)

2. *Southern Region.* This area, comprising the deltaic tracts of the Godavari, Krishna, Cauvery and Tamprabarni and the non-deltaic rain-fed areas of Madras, Andhra Pradesh and Kerala also has three rice growing seasons. The rice season in Madras varies greatly. The first crop is sown between May and December and gathered from September to April. The second crop is sown between October and March and harvested between January and June. Other areas where rice crop covers over 60% of the sown area are Tanjore and Kanara in Madras, West Godavari in Andhra Pradesh. In Kerala also it is an important crop.

3. *Central Region.* The area comprising Madhya Pradesh, part of Andhra Pradesh and Mysore, has its main rice season from June to November-December and second rice season from January to May in some parts.

4. *Western Region.* This area comprising the coastal zone of Maharashtra and Mysore, has only one season from May-June to November-December. Medium or long duration variety is grown, as the crop should mature before the onset of winter.

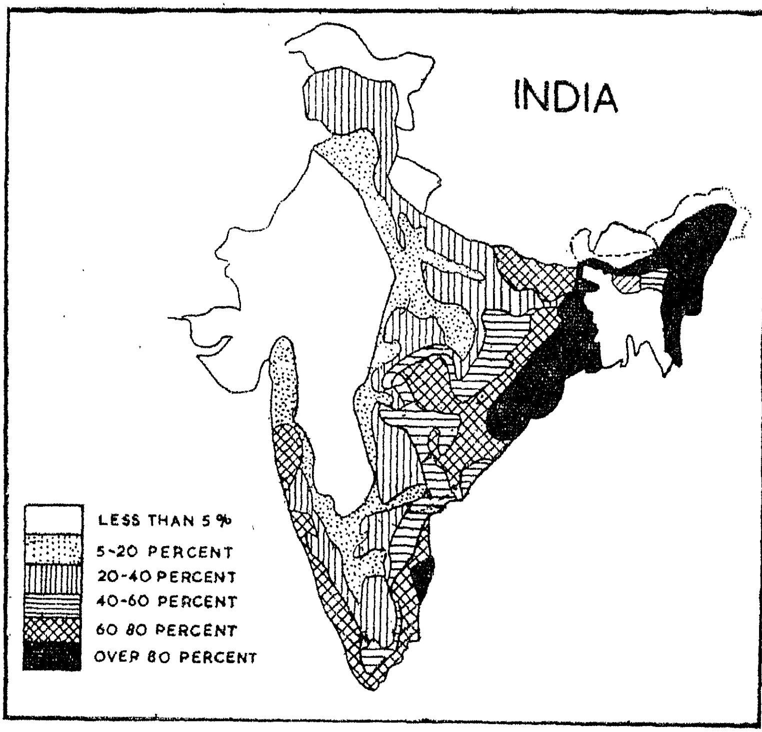


Fig. 28. Distribution of Rice in India

5. *Northern Region.* The area comprising North Bihar, Uttar Pradesh, the Punjab and Jammu and Kashmir, has only one single crop of rice which can be grown from April-May to September-October. In the Punjab rice is grown in the Canal-irrigated areas during Summer only. Rice is also important all along the Himalayas in the Terai region, as well as in the mountain river valleys. In U.P., the eastern districts and the Sub-montane districts are the Chief producer of rice. Rice is, however, also cultivated to some extent in the canal-irrigated areas. There is only one crop of rice raised here. Kashmir is an important producer.

The distribution map 28 of rice shows that there are two areas in India which grow practically no rice. These are the Black Cotton Soil area and the desert and semi-desert of Thar and Rajasthan. There are not enough facilities for irrigation of rice in these regions.

The cultivation of rice in India follows the rainfall line. As one proceeds further into the interior of the country where rainfall decreases, there is a fall in the cultivation of rice. A large proportion of the rice grown outside Bengal and Assam is irrigated. This is specially so where either the rainfall is precarious or scanty. Rice crop cannot bear long intervals of drought. Except in U.P. and the Punjab, there are two to three crops of rice every year, autumn, winter and spring crops.

Rice is considered generally as a winter crop in India, as over the whole of the country it is harvested mainly from November to January. The sowing lasts from April to August for most of the varieties grown in India. But in the main rice producing areas of Bengal, Assam, Bihar, Orissa and Madras there are autumn and Summer crops of rice as well.

The Production of Rice

Except China, about which reliable statistics are wanting, India produces and perhaps consumes also the largest amount of rice in the world. Most of the Indian supplies come from Andhra Pradesh, Madras, Bihar, Orissa, Madhya Pradesh and Bengal. Generally speaking, about one-third of the total crop is contributed by the two states, Bengal and Madras, Bihar and Orissa contribute about another one-third. The acreage, production and average yield in the different states are given in Table XXXXVI.

Table XXXXVI *Acreage, Production and yield of Rice in different states of India*

State	Area '000 hectares	Production '000 tons	Yield per hectare
Andhra Pradesh	2550.4	2946	1035
Assam	1686.8	1631	866
Bihar	4883.6	2553	468
Gujarat and Maharashtra	1602.0	1402	784
Kerala	797.6	927	1068

M. P.	3666.8	2861	681
Madras	2200.4	2525	1077
Mysore	919.2	1083	1056
Orissa	3761.2	2129	508
Punjab	269.6	202	671
Rajasthan	67.6	86	1140
U. P.	3571.2	2433	610
W. Bengal	4063.2	4145	914
J. & K.	183.6	216	1044
Total of the States	30223.2	25139	746
Territory	298.0	337	1013
Total of all India	30521.2	25476	748

Increasing supply

In spite of the large acreage under rice in India the yield per acre is very low. This is due to the absence of manuring in India. The average yield per acre in India is only 1204 lb. (545.17 kgs.) as compared with Japan's 3;7 50 lbs.

The following table shows the yield of rice in selected countries of the world—

Country	Yield
Japan	3,750
China	2,387
Burma	1,420
U. S. A.	3,030
Thailand	1,565
India	1,209
Pakistan	1,244
Egypt	4,628

The highest yield of rice in India is in Bengal. India does not produce rice enough for her own requirements. This deficit will increase as the population increases unless greater otturn of rice is possible. We have already seen that water sets a limit to further extension of rice cultivation in India. The only method, therefore, to increase the output is to increase the yield. The yield at present can be raised only by greater application of manure.

The Government is popularising in this country the Japanese method to increase the yield of rice per acre. The chief features of this method are (i) the uses of less and better seed; (ii) sowing the seed in a raised nursery-bed; (iii) transplanting the seedlings in rows so as to

make weeding and fertilizing easy; and (iv) increasing use of natural and chemical fertilizers like compost, green manures and ammonium sulphate.

The Japanese method of rice growing has been successfully adopted in most States in India. The area under Japanese method of cultivation increased from 4 lakh acres in 1952-53 to 13 lakh acres in 1953-54 and 21 lakhs in 1955-56. This was further raised to 22.4 lakh hectares in 1958-59. In 1958-59 the area under Japanese method stood at 22.4 lakh hectares. The yield of rice per acre under Japanese method is about 20 maunds, whereas under local method only about 11 maunds. The production of paddy is as much as 700 kilograms per acre.

The following table XXXXVII shows the production of rice in India since 1950-51 :—

TABLE XXXXVII : *Rice Production in India*

Year	Area (thousand hectares)	Production (thousand tons)
1950-51	30453.0	20251
1960-61	31156.4	27122
1961-62	33178.8	33658
1962-63	33860.0	34257
1963-64	35961	31512
1964-65	36077	38732

Trade in rice

India's annual requirement of rice exceeds her production, and the deficit is met by imports.

The Indian Government has to import rice from any country with which it can bargain. In 1951 about 7.4 lakh tons were imported, and 3.9 lakh tons in 1958. The imports came from Burma, Thailand and Egypt.

The following table shows the import of rice into India in 1956 and during 1957 to 1965.

TABLE XXXXVIII : *Import of Rice*

	(thousand tons)
1956	325
1957	736
1958	391
1959	290
1960	688

1961	369
1962	390
1963	483
1964	645
1965	783

Rice was imported mainly from Burma, Thailand and Egypt.

The large population of the rice-growing parts of India does not leave any surplus of the crop for export purposes. Most of the trade in rice is inland trade. The largest inland movement of rice is from Madhya Pradesh, a thinly populated area. The largest inward movement is into Kerala, Madras, Maharashtra and Bengal, where the rice-consuming population is considerable, but where the local produce is not enough.

Rice husking mills first clean the paddy and remove the husk before the rice is brought to the market. In the rice-growing areas there are many rice mills, the largest number being in Bengal. In some of these mills, the husk is used as fuel, in others oil-burning machinery is common. The rice straw is tough when dry, owing to the hot and moist conditions under which rice grows. It cannot, therefore, be used as fodder. It is used for that thing of roofs or for making mats. With industrial development of the country it can be used for various purposes like cardboard making and several other packing uses *etc.* These uses can bring to the cultivator plenty of money.

WHEAT

Wheat is the most important grain in India, for people prefer it as a staple food. It is important in areas in which rice is not important, because the climate and soil requirements of the two grains are different.

Climatic Requirements. Although wheat grows in many states of India in different climates, for the period of its early growth it must have moderate rainfall with rather cool, moist weather, long continued if possible. This must then be followed by warm, bright and preferably dry weather. Wheat requires a fertile loam or any other fertile soil, provided it is not too wet. It grows best in a cool, moist climate and ripens best in a warm, dry climate. The ideal wheat climate is that wherein the annual rainfall is between 20 to 30" (50 to 75 cms.) ; the winter temperature is between 10-15° F, and the summer temperature is between 21-26°F and where there exists good facilities for irrigation.

Regions with good wheat

Although wheat is grown in many climate regions, most of the important areas of wheat production have an annual precipitation of less

than 76 cms. Some wheat is even grown in areas receiving as little as 15 cms. per year. The climate of Punjab and Uttar Pradesh with its mild, rainy winter and hot, dry summer is highly favourable for wheat. The largest acreage under wheat is found, therefore, in the drier and higher parts of the Sutlej-Ganga plains. During 1957-58 out of the 118.4 million hectares under wheat in the whole of India more than 6.8 million hectares or about 60 p.c. were in the Indo-Gangetic Valley west of Varanasi and only .4 million hectares mostly in Bihar, in the lower Gangetic Valley east of Varanasi. There is no factor so injurious to wheat as the excessive humidity which marks the eastern section of the Gangetic Valley, both because of higher rainfall and its heavy soil. Madhya Pradesh, U.P., Punjab, Rajasthan, Bihar, Maharashtra and Gujarat States are the chief producers of wheat in India. All these parts are in the interior of the peninsula away from the wet coastal regions.

Thus it may be said generally that wheat cultivation in India increases from the south to the north; that is to say, on leaving the humid atmosphere and the inundated soils of the south and the east. Wheat is practically absent from the red and yellow soils. The other area without wheat cultivation is the Thar desert.

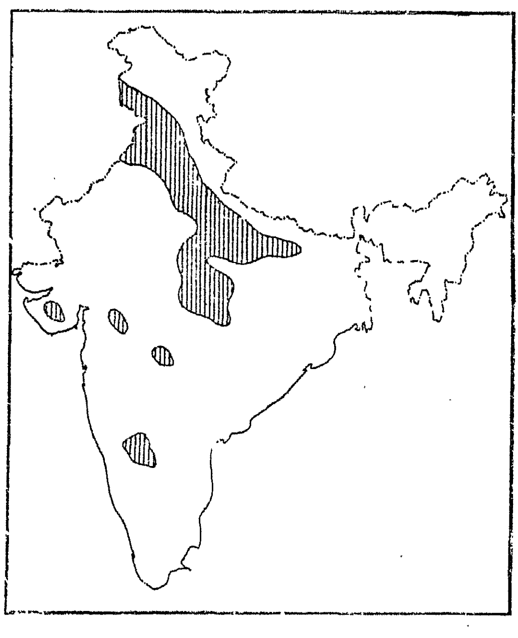


Fig. 29. Distribution of Wheat Cultivation

Wheat Regions. The wheatareas of Indian Republic can be broadly grouped into the following regions according to the Productivity.

(1) *Northern Region*. This area comprising Punjab, Uttar Pradesh and Bihar, has low winter temperatures, the wheat crop can be grown from October to April.

Wheat in Punjab

Before partition the Punjab, with its fertile, alluvial loam, its moderate rainfall, its cool winters and abundant irrigation facilities easily occupied the largest share. On the basis of the ten-year average (1930-31 to 1939-40) two million acres or 29 p.c. of the total acreage under wheat in India was in the Punjab. In 1958-59 in Punjab wheat acreage was 53.50 lakhs and production 23 lakh tons. Most of the wheat area in the Punjab was found in the northern Punjab. Thus, the five districts, Lyallpur, Multan, Attock, Ferozepur and Montgomery accounted for about one-third of the total wheat area of this state. They are all in Pakistan now. It is in the northern Punjab that abundant irrigation facilities are found. This naturally accounted for the importance of wheat there. Not only in area, but in wheat output also the Punjab ranked first in India. About 3 million tons, or 30 p.c. of the total output came from the Punjab. While in area and in total output Punjab stood first in wheat cultivation, its yield per acre was comparatively low. If the average yield per acre is compared, Punjab stood sixth in the provinces, important for wheat in India then. Even the best yield in Punjab was lower than the best yield in some other provinces. The highest recorded in Punjab was 1250 lbs. per acre in Jullundur, which may be compared with 1374 lbs. in Nawabshah in Sind, and 1300 lbs. in Bulandshahr in U.P. After partition, the Punjab became second only to U.P. in wheat production.

Wheat in U. P.

In 1961-62, U. P. had 41,00,000 hectares or about 33% of the total wheat area in India. The total output was 3 million tons or about 30% of the Indian output. In fact U.P. and the Punjab account for more than about one-half of the area and about two-thirds of the output of wheat in India. Most of the wheat area in U.P. lies in the Doab between the Ganga and the Ghagra rivers. More than one-half of the wheat area is in this region. Next in importance comes the Doab between the Ganga and the Jamuna. The least important districts for wheat in U.P. are those lying at the junction between the Peninsular regions and the Ganga plain. The wheat cultivation is also important in the districts east of the Ghagra, owing to the fertile soil and the irrigation facilities from wells. In fact the largest acreage under wheat in U.P. is in the district of Gorakhpur. This is, however, due to the fact that this district has the largest cultivated area in U.P. The pro-

portion of the area under wheat to the total cultivated area in this district is only about one-seventh. This may be compared with the one-third in Meerut and one-fourth in Bulandshahr. Other important districts are Dehra Dun, Saharanpur, Etawah, Moradabad, Budaun, Shahjahanpur and Nainital.

The average yield per acre is the highest in Punjab when compared with other States. Higher yields in Punjab are characteristic only of the irrigated areas in the Ganga-Jumna Doab and in the districts east of Ghagra. It is the unirrigated areas that lower the average yield in U.P.

(2) *Central Region.* The area comprising Madhya Pradesh, parts of former Hydrabad, now in Andhra Pradesh and the region of Cotton soil of the Peninsula, provided the rainfall is less than 100 cms.

15% of the total acreage under wheat in India is in Madhya Pradesh. The principal wheat growing areas of Madhya Pradesh are as follows :

The Narmada Valley in Madhya Pradesh has rich alluvial soils on either side of Tawa nadi, Ganjal nadi, Hiran nadi and other rivers. Most of the wheat area in Madhya Pradesh lies in the Narmada Valley. Thus, the four districts, Nimar, Dewas, Hoshangabad and Jabalpur are the important production areas in Narmada valley.

Other areas where wheat covers most of the sown area are Ujjain, Sagar, Gwalior, Rewa and Bhopal.

(3) *Western Region.* This area, which comprises Rajasthan, Gujarat, Maharashtra and Mysore, has moderate winter temperatures. Wheat in Gujarat is mainly grown in (1) alluvial soils in the Delta of Narmada especially in Broach district of Gujarat (2) Black Cotton Soils of Ahmadabad district.

Wheat in Maharashtra is grown all over the State. But Khandesh, Nasik, Belgaon and Vaijapur are the chief producer of wheat in Maharashtra.

Wheat is, however, also cultivated to some extent in the canal irrigated areas of Mysore state.

Production and Acreage

The Indian acreage of wheat during the year 1964-65 was reported to be 13453 thousand hectares as against 12818 thousand hectares in 1960-61. Production of wheat in the same year was 108,18 and 1,20,78 thousand tons respectively. The average area under wheat in India during the quinquennium ending 1964-65 was 13453 thousand hectares. India has fairly increased her overall wheat production in recent years, is evident from the following table II of wheat production.

TABLE IL : *Production and acreage of wheat in India*

Year	Area (thousand hectares)	Production (thousand tons)
1950-51	9632.8	6360
1955-56	12223.6	8622
1960-61	12818.8	10818
1961-62	13364.0	11849
1962-63	13302.0	10956
1964-65	1345.3	12078

Within the Indian Union, Uttar Pradesh stands out predominantly in acreage followed by Madhya Pradesh, Punjab, Rajasthan, Mysore, as seen from table L.

TABLE L : *Acreage and Production of wheat in India*

State	Area (000 hectares)	Production (000 tons)
Andhra Pradesh	30.8	10
Assam	2.8	2
Bihar	576.6	412
Gujarat & Maharashtra	1286.8	668
Madhya Pradesh	2390.4	1358
Madras	1.6	1
Mysore	348.0	81
Orissa	5.2	3
Punjab	1843.6	1710
Rajasthan	924.0	899
Uttar Pradesh	3950.0	2984
W. Bengal	62.0	43
J. & K.	110.0	74
Total	11532.8	8245
Territory	157.2	103
Total of all India	11690.0	8348

The total output of wheat, as of any other crop, depends on the area harvested and average yield per acre.

Peculiarities of wheat in India

A special feature of the wheat crop of India is that unlike that of the cool temperate countries of the world where alone the largest supplies

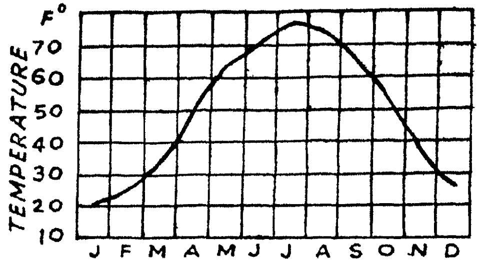


Fig. 30. Temperature required for wheat

of wheat come from, in India it is a winter crop. For it is only then that suitable temperatures are available here. Wheat is sown in India from October to December and is harvested from March to June in different parts. As winter is a dry period over the area where wheat is grown here irrigation plays the most important part in its cultivation in India. In some years when the monsoon rainfall has been in defect, even sowing of wheat is done with the help of irrigation. In Europe and in America, wheat is grown in summer when enough rain falls. Irrigation is, therefore, not an important feature of wheat cultivation in those regions. It is only in Australia, South Africa, and the western part of the United States of America, which are practically deserts, that irrigation is resorted to for this crop. After about a fortnight from the end of monsoon rains in Northern India and when the nights have become sufficiently cool to cause the formation of dew in the field, *i.e.*, about the end of October, wheat is sown in the fields, which have been prepared before hand. Wheat is sown only in the loamy soil of the older alluvium. The field in which wheat is intended to be sown usually remains fallow during summer when a little manure is also given. Unlike most of the summer crops, which are sown broadcast, wheat is carefully sown in the drills made by the plough. This is a clear proof of the esteem in which the Indian cultivator holds it for its commercial importance. The winter rains and the facilities of irrigation in the areas in which wheat is important are an advantage to wheat in India, as they provide moisture to the plant during its early growth which, accompanied by the cool temperature of December, helps tillering, and a number of stalks shoot from the same seed. By the end of February when the grain has formed, temperature begins to rise and help in the ripening of the crop.

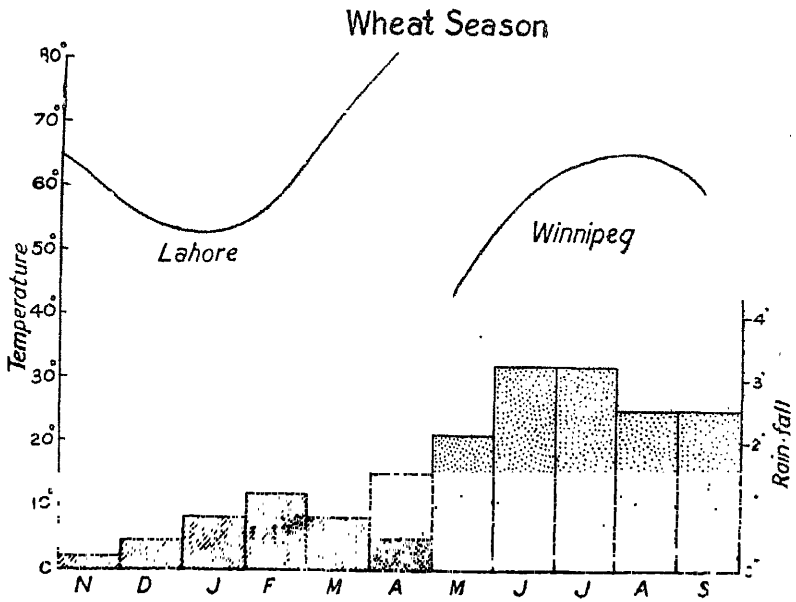


Fig. 31. Showing Temperature

There are certain climatic drawhacks under which Indian wheat is cultivated. These drawbacks arise particularly about the time of harvest. The change from winter to summer is almost sudden in India. The rise of temperature is not gradual, as in Russia or Canada or the other wheat-producing countries, and therefore, the crop matures not gradually but quickly. This sudden ripening of the crop leads to the inferiority of the wheat grain in India. The rise of temperature is usually accompanied by the setting in of very dry winds which quickly dry up the sap in the grain. It is thus not a fully developed well-rounded grain as in other countries, but a shrivelled up and thin grain. This wind often blows with considerable speed and tends to spoil the crop by felling the plant to the ground, as the indigenous Indian plant has a weak straw. Local storms leading to hail and rain are also common in Northern India during March and April and cause difficulties in the gathering in of the crop.

In India most crops are harvested by gathering in the whole plant and not only the grain, as in America, because in India the straw has considerable importance for fodder. Among villages in India, while there is trade in grain there is practically no trade in fodder which has, therefore, to be carefully conserved. This method of crop gathering in India causes considerable amount of impurities in Indian wheat for which it was disreputed in the world market.

See the climatic conditions under which wheat is grown in the Punjab and in Canada. Note from the shape of the curves the sudden and the gradual rise of temperature in the two areas. In India the crop ripens in suddenly increasing temperature, while in Canada it ripens in gradually falling temperature. The amount of rainfall during the wheat season in India clearly indicates the necessity of irrigation. In Canada, on the other hand, rainfall is enough for the crop.

It will be noticed that in India while the *growing period* of wheat is characterised by *favourable* climatic conditions, the harvesting period is marked by *unfavourable* conditions.

The yield per acre of wheat in India is very low, owing to the poverty of the Indian cultivator who cannot afford much manuring. Even though farming here is 'intensive', Indian yield ranks with the lower yields of the newer countries of America or Australia where the farming methods are 'extensive' and cannot, therefore, produce high yields per acre. The yields per acre in the 'intensive' farming countries of western Europe are about three times as much as in India. The largest yield per acre in India is in the western districts of U. P. and the lowest in Chhota Nagpur. It is to be noted that the yield per acre is low in all the important producers of wheat in the world. Russia, U.S.A., Canada, India and Argentina, all record low yields.

The following table shows the yield of wheat in some selected countries of the world—

Country	Field per acre in pounds
France	1,872
Canada	1,512
United States	1,201
Australia	975
Argentina	1153
Egypt	2091
India	640
Pakistan	656

But the difference between U.S.A., or Canada and India is between extensive and intensive agriculture. U.S.A. and Canada generally have extensive agriculture in which less manure is used, and therefore, low yield per acre results. In India lack of manure is due to poverty of the cultivator.

Increased supplies

Shortage of wheat supplies in recent times in India has drawn attention to the possibilities of increasing supplies of wheat in the country. It will be noticed that geographical considerations limit the cul-

tivation of wheat to certain areas of India only. But wheat is a commercial crop in India that is grown essentially for its money value. It has, therefore, to compete with other commercial crops, like cotton or sugarcane. During the last few years, owing to the great rise in the prices of these latter crops, a certain amount of land suitable for wheat cultivation has been diverted to their cultivation. The wheat supplies of India have, therefore, not kept pace with the increasing population of the country. This has naturally resulted in a shortage. Under normal conditions, however, the working of the laws of Economics would adjust the shortage by making it worth-while for the farmers in India to devote more land to wheat. But India needs not only more wheat, but also more cotton and more sugar now. The only method of increasing wheat supplies, therefore, lies :

(i) in extending irrigation facilities to bring more land under wheat cultivation;

(ii) in introducing scientific agriculture by improving seed, manuring, cultivation, *etc.*

Only one-third of the wheat crop in India is irrigated. The other two-thirds of it has still to do without it. If irrigation could be provided for this portion of the crop, increase in supply is bound to occur.

Similarly, the use of manures, better seed and other improvements in wheat cultivation are likely to increase the yield of wheat per acre, and therefore, the total supplies.

Trade in Wheat

India normally stood fourth among the world producers of wheat. But the tremendous increase in wheat cultivation in U.S.A., Canada and Argentina during the last World War has placed India in a lower position. The largest producers of wheat in the world are Russia, U.S.A., Canada, Argentina and India. Indian produce is about one-third of that of Russia and about one-half of that of U.S.A. The commercial significance of the Indian crop formerly lay in the fact that it reached the European market when the crops of other countries were still growing in the field. The importance of this fact, however, has considerably dwindled now, because of the large wheat stocks in the world market in normal times. The demand for Indian wheat in Europe was mostly for mixing with other varieties of wheat to produce a big loaf. Most of the exports went to Great Britain, Belgium, Germany and Italy. Within recent years, owing to the shortage of food in India all exports of wheat from India have ceased. On the other hand, India has to depend on imports of wheat from outside. Only recently India contracted with the U.S.A. for the import of wheat and wheat flour.

The imports of wheat and wheat flour into India for the last some years were as follows :—

Year			Import (lakh tons)
1951	—	—	30.15
1956	..	..	10.95
1957	..	..	28.52
1958	..	..	26.73
1959	..	..	34.97
1960	..	..	43.17
1961	..	..	30.43
1962	..	..	31.99
1963	..	..	40,73 (thousand tons.)
1964	..	..	5621 ,,
1965	..	..	6583 ,,

The largest inland movement of wheat and flour is from the states where it is produced most, *viz.*, the Punjab, U.P. and Madhya Pradesh. The largest inward movement is into Calcutta where a large wheat-consuming population has gathered from the north. Bombay and Rajasthan, where the wheat produced is less than the local demand, are other areas of large demand. The movement is, however, now on government account only and is all over the country according to requirement.

BARLEY

Barley. Barley, like the Millets, is considered as an inferior grain in India. Climate in India does not favour the cultivation of Barley to any large extent. Very high temperatures during the growing period are the main obstacle.

Geographical Environment. Barley grows well in areas where the temperature varies for three months from 10 to 15°C. Barley, being a crop of cold climate, is sown in northern plain of India in winter. Climate plays a dominant role in the Barley production. Barley grows well in alluvium and light clay. The important matters of elevation, aspect and shade, are by no means determined, nor are they attended to as they ought to be. A suitable elevation would seem to have much to do with the successful cultivation, though along with it must be taken the consideration of rainfall. Most parts of Kumaon and Uttarakhand in U.P. is about 915 metre above sea level, and the rainfall is from 125 to 130 cms. But in Uttarakhand Division of U.P., where barley of the highest repute is grown, the elevation is 1370 m. and the rainfall is only 100 cms.

The aspect must be studied, chiefly in the matter of shade, while both the presence of shade and the kind of shade provided are most essential points, in barley cultivation. Perhaps nothing affecting the

cultivation of barley impressed me more than the importance of shade. I have been over some parganas of Kumaon and Uttarakhand, where shade has been attended to, and I have noticed the healthy and natural growth of barley.

It is grown at the same season as wheat and generally in the same way, but with less labour and expense. Thus it gets fewer ploughings, less manure, less water and frequently grow without irrigation.

Barley-Producing Areas

The most important barley region in India reaches from North Bihar, northwest-ward through Varanasi, Terai up into Kumaon region and corresponds roughly with the wheat region, but also laps over into Pilibhit and Kheri districts. Although there have been important shifts in acreage within this area, it has maintained its national dominance for many years.

Two chief zones of barley production are : (i) north-western districts of Bihar—Saran, Champaran and Muzaffarpur, and (ii) north-eastern districts of U.P.—in the districts of Varanasi, Jaunpur, Azamgarh, Ghazipur, Allahabad, Ballia, Pratapgarh and Garhwal.

In higher elevation wheat gradually gives way to barley. Sometimes both are grown in combination. But barley matures ealier and harvesting, therefore, begins about 15 to 20 days earlier than wheat. Some barley is also grown in Punjab. The yield per acre of these grains particularly of barley is higher than that of wheat. They also do not require so much care and attention as wheat, but they are cheaper and do not fetch as much money as wheat. It is, therefore, only under compulsion from nature that the Indian cultivator grows them. His first preference in northern India is always wheat. There is very little in these grains. A small amount of barley is used for brewing beer; while some amount of gram is used as horse or animal feed.

Production and Acreage

The Indian acreage under barley during 1950-51 was reported to be 3113 thousand hectares. The Production of barley in 1950-51 was reported to be 2377 thousand metric tons. The average area under barley in India during the quinquennium ending 1964-65 was 2668 thousand hectares. During this period, the highest acreage was recorded in 1960-61 when it reached a peak of 3205 thousand hectares. The trend of acreage for the quinquennium ending 1964-65 is given in table LI.

TABLE LI : *Acreage and Production of Barley in India*

Year	Acreage (000 hectares)	Production (000 metric tons)
1960-61	3166.5	1975 (000 m. tons)
1961-62	3300.0	1970 ,, ,,
1962-63	—	1841 ,, ,,
1963-64	—	2031 ,, ,,
1964-65	2688	2478 000 tons)

GRAM

Gram is the great spring crop of India. Gram and barley are two other winter grain crops which rank along with wheat as staple food grains of India. Together they occupy about the same acreage as wheat in India. The largest production of Gram is in those parts of the Sutlej Ganga plain where wheat cannot be grown as a winter crop. Gram and wheat mixed together provide the poor man's food in those parts of India where rice is not abundant.

Climatic Requirements. During the sowing season the weather should be cool and wet and the harvesting period requires a hot and dry weather conditions. Ordinarily rainfall averaging 80 to 110 cms. Suffices its growth and it can be grown by irrigation in the dry tracts of the country. The crop needs very thorough tillage if it is to be remunerative and ploughing for it usually begins in the first week of November. The sowing generally takes place in the month of November-December, thereby getting the benefit of winter rains and harvesting usually takes place by the end of April. The crop is cut by sickles and carried to the threshing floor, where the grain is todden out by cattle in the usual way.

Gram-Producing Areas

Gram is grown in almost all the States of India, but its cultivaation is mostly concentrated in flat alluvial tracts of northern India, especially Punjab and U. P., in the states of Andhra Pradesh, Bihar Madhya Pradesh, Maharashtra and Gujarat.

Production and Acreage

The best gram comes from the northern plain, mostly from Punjab and western Uttar Pradesh, and the quality on the whole decreases as one goes south and east. The cultivators in the Southern States are in many cases too poor to undertake the cultivation of this crop, and the area under it is proportionatly less there than elsewhere. The following table LII shows the production and acreage of Gram in India.

TABLE LII : *Production and Acreage of Gram*

Year	Acreage (000 hectares)	Production (000 tons)
1957-58	10943.6	4813
1958-59	11435.6	6881
1959-60	11552.0	5502
1960-61	11341.6	6207
1961-62	9632.0	5850
1962-63	—	—
1964-65	9011[1]	5760

The use of Gram is totally confined to local consumption and its importance from the point of view of commerce is almost negligible. It consists the main staple crop of poor man in India.

MILLETS

Millets include a number of inferior grains in which *Jowar*, *Bajra* and *Ragi* predominate. These grains cover a larger acreage than any other grain in India, except rice. Millets are grown in all those areas

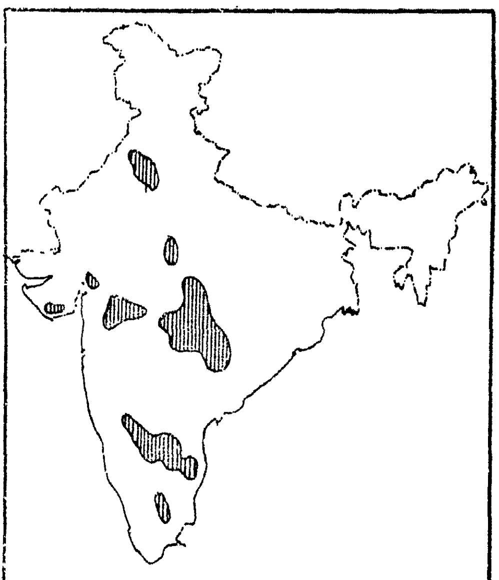


Fig. 32. Cultivation of Jowar in India

1. Thousand hactares.

where the soil is rather infertile owing to its rocky or sandy character. The largest acreage under them occurs in the Peninsular India with Maharashtra, Gujarat and Mysore states leading. The least acreage is in Bengal. *Jowar* prefers wetter and more clayey soil, while *Bajra* grows well in drier and sandier soil. The millets are the chief summer grain crop in all the areas where rice is grown. Their importance lies not only in the fact that they are a staple food for a very large section of the people of the peninsula throughout the year and in northern India during winter, but also in the fact that they provide a substantial part of the fodder supply of India. The fodder value of the Jowar plant is so great that in some parts of U.P. and the Punjab the crop is raised even by irrigation solely for that purpose. Dr. Voelker in his report on Agriculture in India speaks very highly of the nutritive value of Jowar as a fodder. There is practically no trade in millets.

The total India acreage under Jowar in (1961-62) was 172.28 lakh hectares and the production 76.6 lakh tons. For Bajra the respective figures were 108.1 lakh hectares and production 35 lakh tons. Jowar is more important in Maharashtra and Gujarat states as a *Rabi* crop than as a *kharif* crop. These are the only States in India where *Jowar* is grown as a *rabi* crop, as well as a *kharif* crop. *Jowar* is a staple crop where black and mixed black soils predominate, provided the rainfall is moderate and well distributed. Important producers of *Jowar* are Maharashtra, Gujarat, U.P., Madras, M.P., Central Rajasthan, and Punjab. Where the rainfall is excessive it gives place to rice as can be seen in the region of the Malabar coast. On sandy loams and shallow soils its place is taken by *Bajra*. In U.P. and the Punjab *Jowar* is also grown as fodder crop. It is then known as *Chari* and is given irrigation when necessary.

The following table shows acreage and production for Millets,[1] during various years, in the Indian Union.

Year	Acreage (000 hectares)	Production (000 tons)
1950-51	26486.8	9369
1955-56	30648.8	11810
1957-58	30471.6	13761
1958-59	30710.0	14380
1959-60	29948.8	13427
1960-61	30372.4	13859
1964-65	6984[2]	3898

MAIZE

Maize also, like millets, is considered as an inferior grain in India. It prefers fertile soil, especially loam and is, therefore, grown

1. *i.e.*, Jowar, Bajra and Ragi.
2. Thousand hectares.

mostly in U.P., Rajasthan and the Punjab. More than four-fifths of the crop is found in the Sutlej-Ganga Plain. It is grown with the first summer rains and is reaped almost as soon as the rains stop. Its cultivation is adversely affected if the rains come late, and the crop is damaged, if there are very long intervals between the rainly periods. The cultivation of maize as well as the millets in India is characterised by 'interculture'; that is, several things are sown mixed. Among the seeds sown thus, are several vegetables, like pumpkins and cucumbers, various kinds of pulses like *Urd*, *Mung* and *Arhar* and some oilseeds like sesamum. All these except, the *arhar* are collected before the main crop. *Arhar*, on the other hand, takes full winter to mature and is harvested separately with the rabi crops.

This 'interculture' has an important and scientific place in the agricultural practice of India. Some of the crops like the *arhar* have deep tap roots on which form the bacteria which enrich the soil. Interculture has thus its agricultural value. The vegetable crops mature quickly and provide food to the poor agriculturist at a time when his stock of food is at the lowest. Interculture has thus its economic value.

There is only local trade in maize. Its stalks, too, are tough when dry and have no value for fodder. They are generally burnt or used for thatching.

Climate in India does not favour the cultivation of maize to any large extent. Very high temperatures during the growing period are the main obstacle. It will be seen that the region of the greatest production of maize is the United States of America, which produces the bulk of the world's supply of maize has a mean summer temperature of 21° to 26°C.

In India, on the other hand, we notice that the average is more than 29°C. during the period maize is grown here. This unfavourable climate is mainly responsible for the low yield per acre in India in comparison to the United States of America. The following table LIII shows the yield of maize in selected countries of the world—

TABLE LIII—*Yield of maize*

Country	Quintals per hectare
India	9.2
U.S.A.	33.5
Canada	35.8
Argentina	17.7
U.S.S.R.	16.7
Netherlands	38.1
Italy	32.1
Australia	21.1
Japan	15.9
World	20.0

Production and acreage

The average area under maize in India during the year 1950-51 was 3195 thousand hectares. The highest acreage was recorded in 1960-61 when it reached a peak of 4407 thousand hectares. The year 1964-65 saw a further increase in acreage reaching a new height of 4591 thousand hectares. The trend of acreage and Production is given in table LIV below.

TABLE LIV : *Acreage and Production of maize in India*

	1950-51	1955-56	1960-61	1964-65
Acreage in thousand hectares	3159	3696	4407	4591
Production (000 tons)	1729	2602	4080	4558

The crop is raised mainly for consumption in areas of production and hence exports are inconsiderable. In recent years industrial firms have developed the production of starch and glucose from maize.

QUESTIONS

1. Under what geographical conditions are wheat and tea grown in India ? Mention important areas of their production. (A. U. 1962)

2. Analyse the geographical and Economic conditions favouring the cultivation of rice in the Indian Republic and mention the chief areas of its production.

CHAPTER 12
Commercial Crops

Several Commercial or cash crops are grown on a large scale in India, chief among these are cotton, tobacco, oilseeds, spices and condiments, coconut, Jute and lac *etc.* They are of considerable economic importance to the country, providing raw material for internal consumption and serving as valuable sources for earning foreign exchange. The cultivation of all these crops, therefore, needs not only intensification but also extension wherever the conditions permit of such a course.

SUGARCANE

The cultivation of sugarcane has made enormous progress in India within very recent years as a result of the growth of Indian cane-sugar industry under the State protection. Thus, the history of sugar beet in Europe has been repeated in India in the progress of sugarcane. The growth of cane cultivation in India is shown by the rise in area under cane from 1707 thousand hectares in 1950-51 to more than 2400 thousand hectares in 1960-61 and 2544 thousand hectares in 1964-65. The greatest expansion has been in Bihar and U. P. where the best conditions for cane cultivation are found.

Geographical Environment

Sugarcane crops require such geographical conditions as exist in Java and Cuba, where there is a temperature of 20° or 26°C. The year round and the rainfall of 137 cms. or more. Much sunshine is required, particularly at the end of the growing season, to produce cane with a high sugar content. Sugar cane cultivation in India extends from 8° to 32 N. latitude, and the crop is grown under widely varying conditions of rainfall, soil and climate. But certain environmental factors are essential for its development, *viz.*:—

(1) The fertile alluvium which is renewed every year by the numerous mountain streams flowing into the area—Sugar cane grows well in alluvium and light-clay. The soils of the Sutlej-Ganga plain contain nitrogenous materials and here the cane cultivation can be done even without the aid of manures and fetilizers. Although sugarcane is grown in the whole of Sutlej-Ganga plain but the areas of Gorakhpur, Ballia, Azamgarh, Fyzabad, Jaunpur, Varanasi, Kashipur, Nainital (areas of Rudrapur, Bajpur *etc.*), Saharanpur *etc.*, have a commercial production.

(2) High water level enabling easy irrigation—The plain of Sutlej and Ganga provides very ideal climatic conditions for the growth of sugarcane. In this region whenever the natural rainfall lacks, the water from local canals is restored to the water requirements are fulfilled.

(3) High temperatures and Rainfall— The temperature for the sugarcane varies from 20°C. to 260°C but it cannot resist frost. For this reason the cane harvest begins with the approach of winter. The rainfall for its well growth must be from 137 to 150 cms., which is partly supplemented by the canals.

Sugarcane producing areas

At one time India had the largest acreage under sugarcane in the whole world. Indian acreage was about three times that of Cuba and about seven times that of Java, the two islands which have dominated the world production of sugarcane in the past. India was also the largest producer of cane sugar in the whole world, producing about four times that of Java, Hawaii or Brazil, about three times that of Philippines and about one and a third times that of Cuba. Even now India is the third largest producer after Brazil as is evident from the following figures:—

World Production of cane sugar in 1961 (in thousand metric tons).

Cuba	47500	Australia	86410
Brazil	57178	Hawaii	8834
India	86410	Mexico	17863

This great production in India was due not to high yields but to the immense area under sugarcane. The production of sugar in India, however, surpasses all countries producing beet sugar.

The production of sugar in India previously used to surpass all countries producing beet sugar, but recently U.S.S.R. has started producing beet sugar which is even greater than the output of cane sugar in Cuba. However, the production of cane-sugar in India is greater than the production of second largest producer of beet-sugar *viz.*, U.S.A. The following figures for beet-sugar may be compared with the previous figures for cane sugar :—

World production of cane sugar in 1961 (in thousand metric tons).

U.S.S.R.	57728	Poland	10262
U.S.A.	14897	Italy	7554
W. Germany	12860	E. Germany	6837

Even though sugarcane is grown all over India in favourable localities to some extent or the other, because of its great money yield, its

greatest concentration occurs in the submontane districts of the Middle Ganga Valley, where U.P. has 59 per cent of the total Indian crop, the Punjab (11%) and Bihar (17%) together accounts for four-fifths of the sugarcane area of India.

In U.P. the most important districts producing sugarcane are Saharanpur, Shahjahanpur, Faizabad, Azamgarh, Ballia, Varanasi, Jaunpur, Bulandshahr, Pilibhit and Gorakhpur. U.P. raises 49% of the Indian crop.

In Bihar the important sugarcane-growing districts are Champaran, Saran, Darbhanga and Muzaffarpur. Bihar raises 6% of the total Indian production.

In Punjab the cultivation is concentrated in Amritsar, Jullundur and Rohtak. It raises 10% of the Indian production.

There are, however, small areas of one cultivation spread locally all over the country. They have not been shown in the map, because the areas are too small. The existence of such areas clearly proves the importance of sugarcane as a money crop to the Indian cultivator.

The yield per acre of sugarcane is higher in the Peninsular region than in the north. The yield of sugarcane in Maharashtra is 53.25 tons per acre which is even better than Java's yield. The average percentage recovery of sugar from cane is 11.49% in Java whereas it is 11.80% in Maharashtra. The average Indian figure for the recovery of sugar is 9.84%. The reasons for better yields in southern India are more suitable climatic conditions and greater use of fertilizers. The following table shows the yield per acre in some important sugarcane-growing countries of the world :—

Hawaii	80 tons per acre	Philippines	27 tons per acre
Java	50 ,,	Mauritius	19 ,,
Peru	41 ,,	Cuba	17 ,,
Egypt	30 ,,	U.S.A.	20-30 ,,
Puerto Rico	30 ,,	India	15 ,,
Formosa	28 ,,		

In 1958-59 out of the total Indian acreage under sugarcane (of 48 lakh acres) 27.4 lakh acres was in Uttar Pradesh alone, and out of the total sugar production of 704 lakh tons, U.P.'s contribution was 307.6 lakh tons.

The Indian cane is of a thin variety and is not so thick as the cane in Java or other tropical islands where the continued supply of moisture and hot temperatures produce plenty of juice in the cane. In India, the long break in the rains does not favour the growth of thick, juicy canes under average conditions. The cane which has practically supplanted the old indigenous varieties in India is the Coimbatore cane, bearing different numbers according to the seedlings obtained by crossing with different varieties as well as with other plants like Jowar.

Coimbatore has been selected as the centre for researches in sugarcane, because its climate is ideally suited for cane. One important effect of the introduction of the Coimbatore cane has been that 'ratooning' has become popular in India. Ratoon crop is the second or any successive crop of cane obtained from the roots of the cane left over in the field from the first crop. Ratooning avoids the needs of fresh sowing of cane every year. In India ratooning is generally uneconomical after two years, as the crop becomes infested with cane diseases like 'red rot'. The sucrose content of the Punjab cane is, however, lower than that of the canes of U.P. or Bihar. This is believed to be due to the soil differences. The amount of exchangeable calcium in the Punjab soil is lower.

Production and Acreage

Most of the cane produced in India is used locally for crushing in the sugar mills erected all over the sugarcane area in the country. One of the main factors in the rapid increase of sugar cultivation in India has been the demand for cane from these mills. The land lying near these mills, wherever practicable, has all been converted into caneland, the cane replacing all other crops. An important example of this replacement is noticed in the Terai region of the Himalayas where the land, formerly given to rice is now devoted to cane.

Sugar cane is grown in almost all the States of India, but its cultivation is mostly concentrated in Uttar Pradesh, Punjab, Bihar, Maharashtra, Andhra Pradesh, Madhya Pradesh, Mysore *etc.* The average area under Sugarcane in India during the year 1950-51 was 1707 thousand hectares. The highest acreage was recorded in 1960-61 when it reached a peak of 2415 thousand hectares. The year 1964-65 saw a further increase in acreage reaching a new height of 2544 thousand hectares.

Production of Sugarcane in 1950-51 was 5,70,51,000 tons. The highest production was during the year 1960-61 when it reached a peak of 108973000 tons. The year 1964-65 saw a further increase in production reaching 12,21,27000 tons. The following table LV shows the Sugarcane acreage and production in India.

TABLE LV : *Acreage and Production of Sugarcane in India.*

Year	1950-51	1955-56	1960-61	1964-65
Acreage in thousand hectares	1707	1847	2415	2544
Production (6000 tons)	5,70,51	60543	108973	122127

The following table shows the statewise production of Sugarcane during the Third Five Year Period. Data taken from Third Five Year Plan.

TABLE LVI : *Sugarcane Production during Third Plan Period.*

(in thousand tons)

State	Additional Production	Estimated Production	% increases
Andhra Pradesh	123	750	19.6
Assam	20	120	20.0
Bihar	45	730	6.6
Gujarat	31	129	3.16
Maharashtra	300	1180	34.1
Kerala	30	67	81.0
Madhya Pradesh	97	260	59.4
Madras	101	501	25.3
Mysore	97	510	23.5
Orissa	130	230	130.0
Punjab	120	900	15.4
Rajasthan	90	180	100.0
Uttar Pradesh	700	4200	20.0
W. Bengal	59	187	46.1
J. & K.	—	1	—
Union territories	—	18	—
Total	1943	9963	24.2

Problems of Sugarcane

One difficulty in growing sugarcane is, that enough manure cannot be obtained, and dependence has also very often to be put on canals which afford uncertain supplies of water. Again, sugarcane is cultivated in Deccan on a number of small patches, often some distance from one another, and not in large areas, consequently there is considerable loss in cutting and carrying the canes any distance of a factory. There is no doubt that a much larger area of land could be put under sugarcane. More manure could be needed, and perhaps more water facilities also.

The prices of cane per maund are higher than in most other countries although the quality is poorer. Whereas out of 100 maunds of cane it is posible to get 14.33 maunds of Sugar in Australia, 12.23 maunds in Cuba and 11.40 maunds in Java, in India we hardly get 10 maunds. Whereas in other countries the price of cane is fixed on the basis of its quality in India we have to pay the minimum price of sugarcane irrespective of the quality. In spite of the high cane cost there was a serious agitation by the cane growers in U.P., and other States to increase the minimum price of sugarcane. The Government of India

considered their demand to be unjustified and did not agree to increase their price as it would have further pushed up sugar prices. One can sympathise with the desire of the growers to increase their income and purchasing power but for this they must improve their output as well as the quality of cane and not burden the consumers with their inefficiency. The state Governments who have taken upon themselves the task of development of cane and have imposed cane cess for this purpose should assist the growers in this matter. Then there are the canegrowers cooperative societies the establishment of which has resulted in the lack of direct contact between the growers and the factories. These co-operative societies are entitled to a handsome commission from the factories and should take concrete measures to improve the yield and quality of cane.

Another 7% of the sugar manufacture goes to workers as salaries and wages. This is another element over which producers have no control. Wage rates and other amenities are governed by legislation and tribunal awards and nearly every factory carries a load of surplus labour wage rates are low by International Standards but as usually happens in such cases those who criticise the industry for not paying wages received in other countries conveniently overlook the vital matter of labour productivity. Indian wages are low perhaps but labour is not cheap. Whereas in Australia the average production per worker is 144 tons of sugar in India it is only 11 tons. Thus the total labour cost per maund of sugar in India is higher than in most other countries.

As already mentioned, irrigation is almost universal but in several places dry cane-farming is practised. Where irrigation facilities exist, enormous sums of money have been spent in the construction of large water reservoirs where mountain slopes supply all the water needed for sugarcane farming in India. In Sutlej-Ganga plain and other places, undergrouud water is tapped and artesian wells give a constant water supply to the sugarcane fields.

The quality is, however, very poor as its supplies depend on the vagaries of nature. It is evident from the following data that the yield per acre and Sucrose content are much higher in other sugarcane producing countries.

Country	Yield per hectare	Surcose content	Sugar per hectare
Indonesia	40.5 tons	13.4%	5.5 tons
Australia	26.3 tons	15.1%	3.9 tons
India	13.0 tons	12.3%	1.6 tons

The need for improving sugarcane cultivation need not be over emphasised here.

Much of the success of sugarcane in other countries like Australia and Indonesia has been due to the high efficiency attained on the farms. Varieties of cane which may give high tonnage, may be disease-resistant and may possess high percentage of sucrose content, should be evolved.

In India, many different varieties of cane are grown, very little indeed is known as to the yield of respective varieties. In one place one kind of cane is in favour, in another a different kind. Sometimes a cane is required for eating purposes, sometimes one that will resist the attacks of white ants, or one that jackals will not destroy. But, though each may have its special merits, next to nothing is known of the actual amount of Sugar that each will produce.

The native method of sowing sugarcane is to plough the land some 5 to 8 times, the plough going round and round the field and forming a fine seed bed 4 or 5 inches deep. Next, the field is levelled, and the cuttings of seed-cane are scattered broadcast. The seed is then lightly covered over with soil. In consequence, the cane grows irregularly, and a jungle is formed, weeding cannot be properly done, and air and light cannot properly penetrate. In some parts, the cane, instead of being freshly planted each year, is allowed to stand over for a second, third, or even later season, and is then called "ratoon" cane. The advantages are, that much less labour is required, and that only half the amount of manure is used. On the other hand, there are the objections that after a time the land gets sticky, and cannot be worked properly, also that the new shoots spring out from "eyes" higher up the stem than they did when the cutting of seed-cane was deposited below the ground, and in this way roots grow out above the surface of the soil, giving the cane a less firm holding and less power of drawing upon the nourishment placed below it.

OILSEEDS

The importance of oilseeds in India is more for their oil being used for food than for industrial purposes. There is a large variety of oilseeds grown all over India both as a summer and a winter crop, but the greatest importance attaches to groundnuts, cotton-seed, rape-seed and mustard. The yield of the first two of these is generally more than twice the yield of all the others put together. The importance of oilseeds for export trade is considerable also. The oilseeds are divided into two broad classes, edible and non-edible. The latter includes linseed and castor. U. P. is the largest producer of oilseeds in the country.

The table LVII shows the figures for oil-seeds.

Production and Acreage

The total area under all the oilseeds in India in 1961-62 was about 342.2 lakh acres which was more than the area under wheat in this country. About half of this area is in the Deccan plateau. The production amounted to 68.3 lakh tons. The largest area under oilseeds is in U.P

TABLE LVII *Production and Acreage of Oilseeds in India*

(Area in thousand hectares : Production in thousand tons.)

		1950-51	55-56	57-58	58-59	59-60	60-61	1964-65
Groundnut ...	Area	4442·4	5074·0	2346·0	5824·0	7945·0	6182·0	7072
	Production	34,26	38,01	46,36	48,12	39,42	43.54	6176
Castoreseed ...	Area	548·8	567·2	442·0	481·2	467·2	454·0	449
	Production	1,01	1,23	88	1,12	1,06	98	101
Sesamum ...	Area	2178·0	2266·8	2069·6	2200·0	2169·2	1943·2	2530
	Production	4,38	4,60	3,53	5,11	3,59	2,88	466
Rape mustard ...	Area	2044·2	2526·4	2383·2	2408·4	2860·4	2906·0	2814
	Production	7,50	8,46	9,18	10,25	10,47	13,80	1375
Linseed ...	Area	1286·8	1510·8	1268·4	1586·0	1921·6	1693·2	2011
	Production	3,61	4,13	2,55	4,47	4,31	4,10	466

Production of the five major oilseeds for the period of third Plan has been estimated at 9820 thousand tons. The following table LVI shows the statewise production of oilseeds during third Plan period.

TABLE LVIII : *Production in thousand tons*

State	Additional Production in 3rd Plan	Estimated Production at the end of third Plan	% increase during 3rd Plan
Andhra Pradesh	558	1637	51.7
Assam	20	80	33.3
Bihar	66	126	110.0
Gujarat	300	1350	28.6
Maharashtra	321	1039	44.7
Kerala	31	51	155.0
Madhya Pradesh	125	686	22.3
Mysore	175	875	25.0
Madras	290	1340	27.6
Orissa	110	220	122.0
Punjab	115	300	62.2
Rajasthan	110	486	40.0
Uttar Pradesh	495	1675	41.9
West Bengal	20	60	52.0
Jammu & Kashmir	—	11	—
Union territories	—	4	—
Total	2736	9820	38.6

Of this 120 thousand tons were utilized for the manufacture of soaps, paints and varnishes and as lubricants and the net quantily available for human consumption was thus over 1.70 million tons of oil.

Groundnuts are by far the most important among the oilseeds in India from the point of view of area and production. It is an important money crop for the farmer. About one-third of the total acreage under oilseeds is occupied by this one crop. India is now the largest producer and exporter of groundnuts in the whole world, as well as the largest consumer. More than one-third of the world's total acreage under groundnuts is found in India. The importance of this crop in Indian agriculture is only recent. At the beginning of this century there were less than 3 lakh acres under it in India. This importance developed mainly on account of its export value. Today, however,

the home market is more important than the export market, for India now consumes more than three-fifths of the crop. The growing use of *Vanaspati* which is manufactured from the groundnut oil is largely responsible for this. The principal area under this crop is in Madras, Bombay, Andhra and Mysore. Practically the whole crop is grown in the Peninsular India. U.P. is the only important producer outside the Peninsula. The groundnut, apart from yielding the oil which is used for making vegetable ghee, increases the fertility of the soil, because of its bacteria-forming roots. In Mysore Ragi sown after groundnut was produced on an experiment farm 88% more than Ragi sown after Ragi.

Geographical Conditions

The cultivation of groundnuts requires a light soil, perfectly each in organic matter. The red and yellow and the black cotton soils of the Peninsula suit it well. Much rainfall is not required; a rainfall of 20 to 30 inches (50 to 75 centimetres) is quite enough, if it comes during the growing season. In Madras and Bombay part of the crop is raised with irrigation. Groundnuts cannot stand in low temperature; they need a temperature of 70°F to 80°F. (20°C to 25° centigrade). Dry weather is required at the time of ripening.

In the beginning of the present century, groundnut cultivation in India occupied only a minor position, but it has now assumed great importance and plays a vital role in the country's economy. Prior to World War I, the area under groundnuts in India was hardly 10 per cent of the total area under oilseeds; during 1955-56 it had risen to 65 per cent, but in 1961-62 it was about 46%.

Area of production

Nearly 78 per cent of the groundnut area is concentrated in Madras, Maharashtra, Gujarat, Andhra and Mysore, the prominent varieties grown being the Coromandal and peanuts. *Boldnuts* grown in Bombay with a lower oil content, are specially valued for eating as such.

The crop in India was primarily developed as an export commodity and the world prices had a decisive influence on the development of its cultivation in this country. Events, however, have changed the entire pattern of India's groundnuts economy. Exports which occupied a dominant position in pre-World War II years have now given place to domestic consumption. Crushing within the country amounts to nearly 82 per cent of the total production as against 49 per cent before World War II.

Owing to their high fat and protein content, groundnuts form a rich food, but the consumption of kernels is still small, the per capita consumption being only 1.78 lbs.

The groundnut crushing industry has made rapid strides. Crushing in power mills and village 'ghanis' accounts for the largest share

of the groundnuts. There has been nearly cent per cent increase in the production of groundnut oil as well as cake.

The following table shows the acreage and output of groundnut oil in India.

Year	thousand hectares	output of groundnut oil (in 000 tons)
1950-51	4442.4	34,26
1955-56	5074.0	38,01
1957-58	2346.0	46,36
1958-59	5823.0	48,12
1959-60	7945.6	39,42
1960-61	6182.0	43,54
1964-65	7072	61,76

Cotton seed also is mostly produced in the Peninsula. *Coconut* and *Castor* are also almost a monopoly of the Peninsula.

Rape and *Mustard seeds* are very widely grown in Sutlej-Ganga Valley. They are not important in the Deccan, as they prefer a fertile, alluvial soil with comparatively dry winters. Out of the total area of 24.8 lakh hectares under this class about 14.0 lakh hectares are in the northern parts of the country. In the Punjab, the crop is known as Toria. In U.P. this crop is grown alone only over a small area which is only about 3.6 lakh 1.4 hectres. A large amount of this crop is, however, grown in this state mixed with other winter crops. U.P. occupies the highest place in the cultivation of Rape and Mustard. In some places Rape and mustard oil seeds are grown usually in association with the wheat crop. But these oilseeds generally mature ealier than the wheat, but sometimes when the rain interrupted the harvesting, the plants turn green and become mature in five months. But generally it is harvested within 4½ months.

These oilseeds occupy an important place in the daily diet of the peasants. Besides being used as a fatty constituent of the food, it provides oil for lighting the lamps. The remains of the seeds after the extraction of oil, which are known by the name of "Khali" in U.P., provides nutrition to the animals. These oil-cakes also furnish very valuable manures for the fields. But the peasants can't make its use in the form of fertilizer.

Sesamun (*Til* or *Jinjali*) is also very widely grown in India. It is, however, more important in the Deccan than in the Sutlej-Ganga Valley, Madras, Bombay, Andhra and Madhya Pradesh are more important.

The maximum temperature for the Sesamum varies from 21°23°C. The rainfall for its well growth must be from 40-50 cms. Sesamum grows well in light loamy soils.

Nearly 70% sesamum area is concentrated in U.P. Madhya Pradesh, Andhra, Gujarat, Maharashtra and Madras.

The following table shows the acreage and production of sesamum in India.

TABLE LIX *Acreage and Production*

Year	1950-51	1955-56	1960-61	1964-65
Area (in thousand hectares)	2204	2293	2169	2503
Production (000 tons)	445	467	318	466

MAHARASHTRA

Linseed is another important money crop for the Indian farmer. It has acquired a great importance within recent years in Indian agriculture, owing to its enhanced importance for export trade to Great Britain. It now occupies over 12 thousand hectares, most of it lying in U.P. It is, therefore, insignificant when compared with Argentina, in South America.

Linseed, though principally a temperate crop requiring low temperature and humidity for its growth, but is cultivated both in temperate and tropical zones. Almost all types of soils in India, grow linseed.

Linseed is grown in almost all the states of India, but its cultivation is mostly concentrated in Madhya Pradesh, Uttar Pradesh, Bihar, Rajasthan and Maharashtra, which together contribute about 90% of the country's linseed production. Mysore and Andhra Pradesh are the only nominal producers in Indian Republic.

The following table LX shows the acreage and production of Linseed in India.

TABLE LX : *Acreage and Production*

Year	Acreage (thousand hectares)	Production (000 tons)
1950-51	1405	367
1955-56	1529	420
1960-61	1789	398
1964-65	2011	466

Castor is also important only in the Deccan. Andhra, Madras, Mysore, Maharashtra and Gujarat account for practically the whole of the crop, Bihar and U.P. are the only nominal producers outside the Peninsula.

India ranks second in castor seed producers of World, being surpassed by Braizil. The following table shows the production and acreage of Castor seed in India.

TABLE LXI : *Acreage and production of castor seeds in India*

Year	Acreage (thousand hectares)	Production (000 tons)
1950-51	555	103
1955-56	574	125
1960-61	466	107
1964-65	449	101

Coconut. The coconut tree requires heat, humidity, abundant rainfall, and rich, well drained soil. Nearly all the major coconut producing regions in India lie near the sea, a distinct advantage for export. Most coconut is grown where the average annual temperature is between 27 to 30°C. Although, coconut requires a hot climate, in many regions the full blast of the sun is too hot for its growth.

The principal coconut growing regions have an average annual rainfall of about 125 to 130 cms. In a few places sepecially Orissa coconut is grown with as little as 100 cms. of rain in others, with as much as 130 cms. The coconut tree tolerates neither drought nor frost. Soils must be rich and well drained. Some of the best coconut lands in India have rich loamy soils.

Production and Acreage

The coconut is grown on the coast lowlands, the windward South-eastern side having sufficient rainfall for the crop in most places, but on the drier inland side irrigation or flood is necessary.

Coconut production in Kerala has about reached its economic limit because most of the suitable land has been planted.

Within the Indian union, Kerala stands out predominantly in acreage followed by Mysore, Madras, Andhra Pradesh, Maharashtra, W. Bengal and Orissa, as seen from table LXII.

TABLE LXII : *Acreage Under coconut in different states in India*

State	Acreage (thousand hec.)
Andhra Pradesh	34.4
Assam	.8
Bengal (West)	6.8
Kerala	458.0
Madras	50.4
Maharashtra	5.2
Mysore	85.6
Orissa	4.4
Andaman & Nicobar Islands	1.6
Laccadive, Minicoy & Amindivi	2.4

The average area under coconut in India during the year 1950-51 was 622 thousand hectares. The year 1960-61 saw a further increase reaching a new height of 717 thousand hectares. The production of coconut in 1950-51 was reported to be 358 crore nuts. The following table LXIII shows the production and acreage of coconut in India.

TABLE LXIII : *Acreage and Production of Coconut*

Year	Acreage thousand hectares	Production crore nuts
1950-51	622	358
1955-56	647	423
1960-61	717	464
1964-65	N.A.	N.A.

TRADE

The exports of oilseeds have, on the whole, now decreased. Groundnut is an exception, the marked increase in its export being due to an increase in area. The exports of oilcakes and vegetable oils have also increased, but the increase in the quantities of oilseeds crushed for local consumption is still more striking. From the increased quantities of oil manufactured in India, various minor industries have developed, *e.g.*, soap-making, hair-oil-making, paint and varnish-making and vegetable ghee-making. Gouripore in Bengal is now famous all over India for the supply of boiled linseed oil for the paint and varnish industry.

The export of oilseeds is not profitable to India. It is against the real interests of the country. The main arguments against this export are that by exporting the raw oilseeds to foreign countries :—

(1) India loses the oilcake which is a valuable manure for the soil and a nutritious cattle fodder.

(2) India has to buy back from these countries at a high price the vegetable oil that it needs for her industrial purposes like the making of paints and varnishes and soap, *etc.*

(3) India thus pays the higher wages of the foreign labour employed in oil-crushing industry in foreign countres, while depriving her own people of the work and the wages they could get in crushing in India.

(4) The development of our industries like soap-making, *etc.*, is retarded for want of cheap vegetable oils.

The policy of central Government is to allow the export of vegetable oils rather than the oilseeds for two reasons—first, to promote the development of oilseeds crushing industry in India, and secondly to have oilcake within the country. Export of oilseeds had, threfore, remained banned for some years.

TOBACCO

The cultivation of tabacco is one of which great care is bestowed. Like sugarcane, the crop carries with it considerable profits, but it is almost entirely grown upon good land and both manure and water are available. Speaking generally, the crop is grown in rotation with other crops, but it is not unusual in some states of India to grow tobacco year after year on the same land. In Andhra Pradesh and Maharashtra it is, the common opinion that the quality of tabacco is much improved by the continuous growth for many years on the same spot, and fields can be pointed out which have produced tabacco for ten years and more and are specially noted, the produce often fetching quite "fancy" prices.

Geographical Environment

Tabacco requires a good soil and heavy manuring. The best kind is a well-drained, friable, sandy loam, not too rich in organic matter, but rich in mineral salts like potash, phosphoric acid and iron. Light soils which allow a full development of the roots of tobacco are the best for it. But heavy soils are used in India for growing Hookah Tboacco. It is most susceptible to frost. Tobacco is grown mostly wherever the soil is a rich sandy loam with water only few feet below the surface. Shallow wells are dug all over the tobacco fields, and during certain stages of the growth of the crop hand irrigation is done daily. Tobacco is grown principally as a garden crop, but sometimes also as a dry (unirrigated) crop, the seed-bed only being watered by hand. The irrigation is followed not only to supply moisture to the roots but also to wash the dust from the leaves.

The tobacco plant is injured by frost, but it grows in a comparatively short season, so that profitable crops ripen as far north as Kumaon, while it is at home throughout the Deccan.

Cultivation

The process is the sowing of Tobacco-seeds in small beds. When the plants attain a height of 10 to 12 cms., it is carried to the larger fields, and the plants, planted in the wet soil.

Curing of tobacco as conducted by the people is done in a very primitive way. The leaves are not removed one by one when ready for picking, but after a few spots have begun to appear on the lower leaves, the entire plant is cut off close to the ground, and is left exposed to the night dew. Next day the plants are arranged in small circular heaps, about two feet high, with the stalks outwards. At the close of the day the heaps are opened, and the leaves are spread out for the night. The next day they are heaped again, and so on until after about five days they begin to turn yellow. Then the plants are hung upon horizontal poles for 10 to 15 days, the stalks being pressed close to each other. After this the leaves are again packed in square heaps, and these heaps

are opened and re-packed every two or three days. The leaves begin then to sweat and finally to turn black. This blacking is a sign of fermentation being finished, and the leaves are then stripped off the stalk and tied up in bundles and baled. Often, water are sprinkled on the leaves after fermentation is over. This process of curing is evidently a very crude one, and admits of very great improvement.

The Indian variety of tobacco (Nicotiana Rustica) is a more rapidly growing species other than the variety generally grown in the temperate regions of the world (Nicotiana tabacum). In the field this tobacco grows most rapidly with a mean temperature of about 26°C. It also requires a liberal, well-distributed rainfall or its equivalent in irrigation water. For the water requirements of the plant are high. Tobacco plant is also very sensitive to defective drainage or waterlogging of the soil. It needs well drained soil.

In the cultivation of tobacco it is the quality of leaf rather than quantity that is aimed at. High yields of leaf always imply a rank vegetative growth. For good cigarette tobacco, therefore, relatively low yields are essential to the production of leaf of the highest quality.

Tobacco-producing Areas

Tobacco is grown in almost all the states of India, but its cultivation is mostly concentrated in the river valleys, deltas and low lying coastal areas in Andhra Pradesh, Mysore, Maharashtra *etc.* Within the Indian Union, Andhra Pradesh stands out predominantly in acreage followed by Gujarat, Mysore, Madras, Maharashtra, Uttar Pradesh, Bengal, Bihar, Assam and Rajasthan, as seen from table LXIV.

TABLE LXIV : *Acreage under Tobacco in different states in India.*

State	in thousand hectares
Andhra Pradesh	134.0
Assam	9.6
Bengal	16.0
Bihar	14.0
Gujarat	66.0
J. & K.	—
Kerala	.4
Madhya Pradesh	3.2
Madras	10.0
Maharashtra	28.4
Mysore	42.0
Orissa	4.4
Punjab	1.6

Rajasthan	3.6
Uttar Pradesh	13.6
Delhi	.4
Himachal Pradesh	.8
Manipur	—
Tripura	.8

More than 2/3 of the acreage and output of tobacco in India are found in the States of Andhra Pradesh, Madras and Maharashtra.

In Madras, tobacco is grown in all districts, though on the Nilgiris and the western districts the area is small. In Madras the most important districts producing tobacco and Madurai, Coimbatore, Tiurchirapalli, Thanjavur *etc.*

In Maharashtra the important tobacco producing districts are Kolhapur, Sangali, Giraj, Belgaon, Satara *etc.*

In Punjab the cultivation is concentrated in Amritsar, Gurdaspur Ferozpur *etc.*

In U. P. the most important districts producing tobacco are Varanasi, Meerut, Mainpuri, Bulandshahr, Saharanpur, Farrukhabad *etc.*

Tobacco is also grown in Kaira district of Gujarat. In Bihar Tobacco cultifation is concentrated in Muzaffarpur, Darbhanga, Monghyr *etc.*, and Purnea in West Bengal. In West Bengal the deposits are rich in calcium and magnesium and also contain sometimes, half decomposed organic matter. These occupy a majority of the tobacco areas of West Bengal.

Production and Acreage

The Indian acreage of Tobacco during 1960-61 was 401 thousand hectares as against 357 thousand hectares in 1950-51. The average area under tabacco during 1964-65 was 423 thousand hectares. The Production of Tobacco in 1950-51 was only 2.61 000 tons. The highest production was recorded in 1960-61 when it reached a peak of 307. The year 1964-65 saw a further increase in production reaching a new height of 370000 tons. The following table LXV shows the production and acreage of tobacco in India.

TABLE LXV : *Production & Acreage*

Year	Acreage (thousand hectares)	Production (000 tons)
1950-51	357	261
1955-56	410	303
1960-61	401	307
1964-65	423	370

The increase in the production of flue-cured and other types of cigarette tobacco, in India has led to a decrease in the imports of ready-made cigarettes into India. The number of flue-curing barns in operation, on the principles evolved at Pusa, now exceeds 2000.

Trade

About 80% of the total output of tabacco in India is consumed internally. In 1960-61 consumption of Tobacco in India was expected to be 648.32 million lbs., which is supposed to rise to 799.52 million lbs. in 1965-66. Despite the increasing consumption of tobacco India exports 45 to 50 thousand tons of good quality tobacco and earns the foreign exchange to the value of Rs. 10 to 12 crores per year. U.K. U.S.A., Ceylon, Aden, Belgium, Singapore, Poland *etc.*, were the chief importing countries. The main importing countries were—

U.K.	65.3%
U.S.A.	7.3%
Ceylon	4.0%
Aden	3.4%
Belgium	1.8%
Singapore	1.8%
Poland	1.8%
Others	14.6%

Exports of Tobacco

(in Crores of Rupees)

	1960-61	1961-62
1. Tobacco Leaf	14.67	14.03
2. Cured Tobacco	1.13	0.91

This crop did not figure in the first Five Year Plan. In the Second Plan period, distribution of pure seed of Virginia and *bidi* tobacco was intensified with the primary aim of improving the quality of tobacco grown both for use within the country and for export. The production of tabacco during the Third Plan period was 325 thousand tons.

The importance of India tobacco is considerable as a money crop. It is used in large quantities in the making of *Bidis* which are growing in popularity among the masses. In World production of tobacco India ranks high, contributing about one-fifth of the total.

QUESTION

1. Analyse the geographical conditions favouring the cultivation of Sugarcane in India and mention the chief areas of its production. (A. U. 1966)

2. Under what geoeraphical conditions are oilseeds grown in India ? Discuss their importanee as industrial raw materials. (A. U. 1964)

3. Discuss the Indian production and trade in oilseeds or coconut.

CHAPTER 13

Commercial crops (Contd.)

Plantations are basically on agricultural industry and in India, where the dominant industry is agriculture, it should naturally form a part of agriculture and the only reason why it is looked upon as an industry by itself, apart and distinct from agriculture in this country, is because, while agriculture is moving in the traditional rut, over most part of the country, and has degenerated into fragmentations of the worst type and subject to the most obnoxious vices of under-capitalisation inspite of the much-boosted cooperative movement, the essential basis of plantations industry is its large scale exploitation to which agricultural holdings do not lend themselves.

As a matter of fact, plantation industry in its proper form, cannot be conceived of except on a large scale so as to admit of modern concepts of personnel management and commercial exploitation financial administration to be applied to the fullest extent as in any other large organised industry. Anyway in India plantations claim to be the earliest and the largest employer of labour. They produce consumer commodities for home consumption and exports of such a large scale that the total value of such exports exceed that of any other commodity. The Indian plantation industry is made up of Tea, Coffee, Rubber and Cardamom.

The premier plantation industry of India is tea (grown mostly in the North. 78 per cent of the area falls between W. Bengal and Assam and 20 per cent in the South of the Peninsula of which slightly more than half is in Tra-Cochin (now in Kerala State) which produced 690.1 million lbs. as against the total world production of about 1500 million lbs. contributing very largely to the (Central and State Revenues, earning large quantities of foreign exchange and giving employment to more than a million and a quarter persons. How many people realise while drinking his morning cup of tea that a little over 100 years ago, this great industry was non-existent. The creation of India's tea industry is a story of adventure, an outstanding example of the pioneering spirit and a triumph, not only over the jungle with its wild animals and disease but also over a strong prejudice in favour of China tea as compared with the indigenous plant.

Tea is now the important money crop in India. The cultivation of tea was started in India by the Government, as an experiment, in 1834. This experiment was undertaken as a result of a minute recorded by Lord William Bentinck, the then Governor-General of India. It was urged in that minute that great "advantages would result to India, ins commercial point of view, from the success of the scheme, and that it would also place England in an independent position in respect to China." A committee of thirteen members was appointed to start the scheme. Two of the members of the committee were Indians and the rest Europeans.

The Committee obtained a quantity of seed and a few seedlings from China which succeeded well in the soil of Assam. A few tea-makers and artisans were also introduced from China in 1937. Some consignments of the tea thus produced in Assam were then sent to London for sale. These consignments proved of excellent quality and fetched a very high price. The prices commanded by this tea were so good that the experimental tea cultivation in India attracted the attention of British capitalists. A company, later known as the 'Assam Company' was, therefore, formed for tea cultivation in Upper Assam. The Indian Government transferred to this company most of its gardens and nurseries.

The Committee appointed by the Government also discovered that the tea plant grew wild over a tract of Assam, extending from Sadia to Yunan, the frontier Province of China.

The tea plantation in India was, therefore, started with three types of plants : the Chinese type, the indigenous type, and the hybrid type (a mixture of the first two).

The China type is very hardy and yields under circumstances that would be fatal to the more delicate indigenous or the hybdri type. But the China type produces a hard leaf which costs more in manufacturing and is of less commercial value than the tea produced from the indigenous or the hybrid types. The hybrid type has, therefore, become popular in India.

India is the largest producer of tea in the world. About 47% of the total world production of tea came from India in 1961 and about 30% from Ceylon. The crop is, however, highly concentrated in a few hilly districts of India. 76% of the total area under tea plantations lies in Assam (in the Brahmaputra and Surma Valleys) and in the two adjoining districts (Darjeeling and Jalpaiguri) of Bengal. The elevated region over the Malabar Coast, in Southern India (including the Travancore-Cochin, Malabar, Nilgiris and Coimbatore) contains 19 p.c. of the total. The Punjab, U.P. and Bihar account for the rest. There are about 7,273 registered gardens with a total area of nearly 321600 hectares under tea. Of these 238012 hectares are in Assam and West Bengal, while Madras, Mysore and Kerala account for nearly 71184

hectares and the rest are in Bihar, U.P., Tripura, Punjab and Himachal Pradesh. The daily average number of persons actually employed in 1956 was 10,62,036. The tea industry as a whole gives employment to a labour force of almost 1.2 million. The capital invested in tea industry amounts to Rs. 113.06 crores of which about 36% is Indian and the rest non-Indian. There are about 7273 registered tea estates in India comprising about 121600 hectares. These estates employ about 9 lakh people in the tea industry and the capital invested amounts to Rs. 113.06 crores of which about 36% is Indian and the rest non-Indian. The following table shows the comparison of area & produces of tea in the world during the year 1960.

	Area (in '000 hectares)	Production (in '000 Metric tons)
India	128.4	320
Ceylon ..	92.4	197
China ..	—	158
Indonesia ..	56.4	41
Japan ..	18.0	58
Pakistan ..	12.4	19
U.S.S.R. ..	—	37

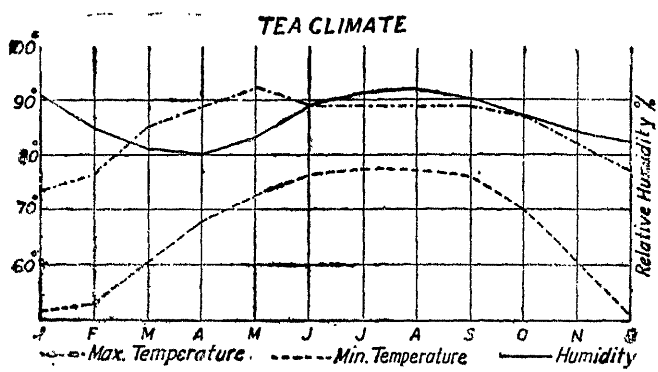


Fig. 33. Meteorological Observations at Jalpaiguri, Bengal

Geographical Conditions

The ideal climate for the cultivation of tea is the one where the daily variation of temperature is from 22° to 28°C. If the atmosphere is very moist, this variation may be a little greater. A rainfall of about

sixty inches annually, if it is well distributed throughout the year, is enough. Nothing is more injurious to tea crop than long dry periods.

The previous graph shows at Jalpaiguri, an important producer of tea in India, the temperature during the producing period from June to September varies between 78° and 89°F. (26°C and 32 C.) The relative humidity of the air, that is to say, the proportion of moisture in relation to the temperature, during this period is very high; about 90%. From March to May, the temperatures are very high and the range between the highest and the lowest temperature great, as is seen from the distance separating the lines of minimum and maximum temperatures in the graph. During this period, however, the relative humidity is very low, when compared to other months. But even this low relative humidity is never below 80%. This fact is an important climatic factor favouring tea cultivation in this district.

A soft and well-drained soil is the best for this crop. Light sandy and deep loams are much preferred. Apart from the production of leaves on the tea-bush, the flavour of tea depends largely on the chemical constituents of the soil. Relatively large quantities of phosphorus and potash in the soil account for the special flavours of the tea produced in Darjeeling. The soils in which tea is grown in the Himalayas vary considerably, but the best is a light, rich soil containing a good deal of humus mixed with sand.

The tea shrubs grow on well drained lands as stagnant water is harmful to the plant, so that hill slopes are particularly preferred, though if the drainage is good, it grows equally well in valleys.

Methods of Cultivation

The tea plants are raised from seeds and not from cuttings. The plants, reserved for seed production, are not used for gathering the leaves, but are allowed to grow to a height of 20 or 30 feet (6 metres to 9 metres). The seeds are sown in nurseries and the seedlings, when about six months old, are then planted in fields which have been specially prepared before-hand.

The sowing of seeds starts in October or November and continues up to March. The seedlings are transplanted when the rains begin. During dry periods after transplantation irrigation has to be provided to help the plants to grow up. The plant is ready for plucking in three years. The season for gathering leaves commences about the beginning of April and continues until October. There are generally three gatherings from each plant every season. The first is some time from April to June, the second from July to August and the third from September to October. The number of gatherings, however, depends entirely on the nature of the season. If the season is good, that is to say, if rain falls in winter and in spring, as many as five gatherings may be obtained.

Pruning of the plant is an essential part of tea cultivation. It is done annually during the period when the plant growth has stopped. In India the period of pruning is generally from December to March. The aim of pruning is to have new shoots bearing soft leaves in plenty. It also keeps the tea bush low enough to facilitate the plucking of leaves from the ground.

In order to help the plant to grow plenty of leaves, considerable attention is paid by the tea-planter to maintain it in good health. Frequent tilling of the soil to eradicate weeds, and the use of several kinds of manures is generally practised. The most common manures in India are the oilcakes. Recently, green manuring has also been practised. In Ceylon, large quantities of chemical manures, like sulphate of potash are used.

In India, tea is grown in three different climates :—

(i) in the cooler climate of the hills—Darjeeling, Kumaon, the Nilgiris and the Kangra Valley.

(ii) in the warmer climate—Lower Assam.

(iii) Midway between the above two—Upper Assam. The districts where the indigenous tea plant was found growing wild.

The third is about the best climate for tea in India.

There is an intimate connection between the climate, the yield and the quality of tea in these areas. In the hilly areas mentioned under (i) above, the yeild is low, but the quality is good; in the areas under (ii) above, the yield is the heaviest, but the quality is worse. The area under (iii) above must be regarded as a whole, midway both in yield and quality between (i) and (ii).

Tea growing Regions

Tea growing in India is confined in the north, East and South India.

1. *North India*. The areas of cultivation of tea in the north of Ranchi, Dehra Dun and Kangra Valley. Ranchi tea gardens are situated in the Chhota Nagpur Plateau, about 610 metres above sea level.

The Dehra Dun tea gardens are situated in the "doon" between the Himalayas and the Siwalik Hills. There are public companies, private companies and private estates. There are now over 33 tea gardens in the Dun, forming 23 separate estates, several gardens belonging to the same company. The total area under tea, according to present estimate, is 1988.8 hectares, *viz*.—

in the western Dun	1748.8 hectares
In the eastern Dun	240.0 ,,
Total	1988.8 ,,

A fair crop is gathered, most of it being converted into green tea and sold in Amritsar and Calcutta.

The Kangra Valley tea gardens lie in the valleys on the foothills of the Himalayas in the Punjab but the climate is not very favourable. A small area of tea is also cultivated in Mandi.

Besides these, Kumaon and Uttarakhand have also a few hundred hectares of tea under cultivation. At present there are several tea gardens in Kumaon and Uttarakhand. The Benital tea garden, which is situated in Patti Chandpur Malla, though covering 620.0 hectares of land, has only 48.0 hectares under tea cultivation. It is a small tea garden situated in the interior of Garhwal district. The average yield per hectare is about 40 lbs.

The Silkot tea garden in Lohba, is the biggest tea plantation in Chamoli district, which covers an area of 284.8 hectares under tea plantation and its average yield comes to 120 lbs. per .4 hectare.

The Mujeti tea garden is in a rotten condition. There are hardly 100 tea plants, which are left more or less in the wild condition. Here the tea plantation has been totally abandoned.

The Gadoli tea garden, practically no tea is produced and manufactured here. There are hardly 50 to 60 plants and approximately 100 lbs. of black tea made every year for home consumption. There is no factory.

The Gwaldom tea garden is situated on the border of Garhwal, Chamoli and Almora and it is more easily accessible from Almora side than from Garhwal. This estate has now been awarded to ex-soldiers and the whole state has been divided into several small tea states. Here the acreage under tea is 24.0 hectares only and the average yield per .4 hectare is 250 lbs.

The Talwari tea State, Tharai is also situated on the border and the area under tea is 12.0 hectares only. The tea yield per .4 hectare is 200 lbs. This state has also been given over to ex-soldiers.

Jurani tea state, which is situated on the way to Badrinath hardly covers an area of half an hectare and the production of tea is practically nil.

A small area of tea is also cultivated in Pithoragarh district.

In Kumaon and Uttarakhand the tea cultivation is done only by the rich pensioners in the form of plantation.

The tea is of black variety and is not so much important from the view point of State trade. In Kumaon and Uttarakhand the average yield of tea is very poor. This is because the tea gardens, in these districts are really not being run on a commercial scale. A large part of the tea is consumed locally and small quantities of black tea are sent out of the district of wholesale dealers in the plains.

Kashmir is very suitable for growing tea so far as climate and soil are concerned. But unfortunately lack of labour and of transport facilities greatly hamper the development of tea cultivation in the state.

2. *East India.* In Brahmputra Valley in Assam most intensive cultivation of tea is found on the red alluvium soil which forms small plateau in the district of Tezpur and Bisnath. In the Surma valley the tea gardens of Cachar are in long narrow valleys running into the tributary Barak of Surma River.

The largest production of tea in India comes from the following areas :—

(*a*) *The Brahmputra Valley in Assam.* The *most* intensive cultivation of the tea here is found on the red alluvium which forms small plateaus in the districts of Tezpur and Bishnath.

(*b*) *The Surma Valley.* This valley comprises mainly of Cachar district. There are many *tilas* or low hillocks all over the district. These hillocks are surrounded by low-lying flat land, locally known as *beel*, which was formerly a swamp. These swamps have now been drained, and in many cases black soil highly charged with organic matter has been uncovered. On these soils tea flourishes exceedingly well. In addition to these flat lands, tea has been planted also on plateau land similar to that in the Brahmaputra valley.

(*c*) *The Duars.* There is a strip about ten miles broad lying at the foot of the Himalayas, south of Sikkim and Bhutan. The most characteristic feature of this strip is a bank of hard but porous red soil on which tea has been extensively planted.

The greater yields of manufactured tea per acre plucked are recorded in the Brahmaputra Valley of Assam. The average yields here are more than 700 lbs. per acre. The lowest yield is in Garhwal, about 60 lbs. to the acre.

3. *South India.* The tea gardens of south are located on the hills and slopes of western Ghats. On Nilgiri hills, north of Palghat gap is an important tea area. The Nilgiri-Wynand and Malabar-Wynand tea gardens are situated on the strip between the Nilgiri and Malabar Coast at an average elevation of about 915 metres above sea level. The tea gardens of Kanara and Davans are at an elevation of 1524 metres above sea level.

Processing Varieties of Tea. Most of the tea produced in India is 'Black Tea'. Very small quantities of 'Green Tea' are produced here. The Kangra Valley is responsible for producing more than two-thirds of the Green Tea in India.

The difference in the black and the green teas is, of course, one of the methods of the preparation of the leaf. The Chinese green tea is coloured artificially by ferrocynide or iron and Prussian blue which

gives them their fine bluish colour. No artificial colouring of tea is, however, done in India.

The manufacture of tea or the preparation of the leaf for the market is comparatively a simple process. It involves the drying of the leaf partly in the sun and partly on fire. The proximity of forests of tea plantation is an advantage, because it gives charcoal for fire and wood for packing boxes. In nature, all the tea leaves are green.

Area under cultivation

Total area under tea cultivation in India is 340 thousand hectares. Nearly 76% of the cultivated area lies in Assam and in the two districts of Darjeeling and Jalpaiguri in West Bengal and about 19% in South India including Annamallai in Coimbatore district, while 3% to 4% in Uttar Pradesh, Bihar and Punjab. The following table LXVI shows the yield and area under tea cultivation.

TABLE LXVI : *Yield and Acreage Under Tea*

State	Area under tea (in hectare)	Average yield per .4 hectare in lbs.
Assam	157366.8	904.23
West Bengal	80648.4	824.47
Kerala	38832.8	807.58
Madras	30564.0	946.81
Tripura	4980.8	370.78
Punjab	3842.4	258.36
U. P.	2360.4	275.52
Mysore	1886.8	765.52
Bihar	616.4	121.17
Himachal Pradesh	417.6	109.97

The position of Assam is outstanding. In Assam the most important, districts are Darrang, Sibsagar, Lakhimpur and in Cachar, Sadia. Frontier division also grows large amount. In southern India, roughly about half of the production comes from Kerala. The Punjab and U.P. and Bihar produce only minor amounts. In the Punjab it is grown in Kangra Valley; in U.P. in Kumaon and Uttarakhand Divisions and in Bihar in Purnea, Ranchi and Hazaribag.

Production

Production of tea in 1950-51 was 275 000 tons. The average area under tea cultivation during the same period was 230 thousand hectares. The highest production of tea was recorded during the year 1960-61 when it reached 321000 tons. The following table LXVII shows the production of tea in India.

TABLE LXVII : *Production of Tea*

Year	Production (000 tons)
1950-51	275
1955-56	285
1960-61	321
1964-65	540*

Exports—(Heady)

Until recently, the Indian tea industry depended for its prosperity almost entirely on the foreign market, especially British. The exports of Indian tea are the largest in the world and are taken mostly by Great Britain which accounts for about 87 p.c. of our exports. A considerable proportion is re-exported from there to the European countries in which Russia is the most important. Russia is, however, developing her own tea plantations in Georgia. Turkey is also growing tea in the neighbourhood of Ria on the Black Sea. Canada, U.S.A., Iran, Ceylon and Burma also take our exports. Among all the producers of tea India has the largest home market.

Thus, not only is the tea production in India confined to a small area but its trade is also limited almost to one market —Great Britain.

Practically all the exports of Indian tea go from the port of Calcutta to the following destinations percentage of which is given below for the year 1961-62 :—

U. K.	59.9%	Sudan	2.6%
U. S. S. R.	7.1%	..	..
Egypt	7.0%	Iran	2.1%
U. S. A.	5.2%	Turkey	1.9%
Canada	3.0%	Others	8.4%
Irish Rep.	2.8%	=Rs. 1224 million	

The following table shows tea exports from the Indian Union to other countries :—

TABLE LXVIII : *Quantity value of tea exported from India*

Country	1963		1964	
	Quality (tons)	Value (000 Rs.)	Quality (tons)	Value (000 Rs.)
United Kingdom	134576	812621	120424	720640
U. S. A.	9954	58014	9346	52710

*No final estimates.

Canada	5219	31753	5441	34052
Iran	3176	26748	1799	10178
Egypt	16776	86680	15768	80232
U. S. S. R.	16788	110526	20810	136944
Irish Republic	7256	46121	4964	31387
Sudan	3610	17122	3559	16872
Australia	3580	17803	5339	27411
Turkey	1237	26748	43	237
Iraq	2511	13424	1799	10178
Netherlands	2887	18066	3572	19716
W. Germany	1476	11427	1919	16368
Newzealand	412	2308	382	2105

The application of restriction to the tea industry since 1933 has resulted in many gardens producing the permissible crop from a smaller acreage than they are at present cultivating. This has resulted in throwing out of commission the poorer producing area and obtaining the crop from the areas producing the greater crop. The poor areas so thrown out of commission are being replanted with new and better plants so that in a few years' time, when these plants become mature, such areas will have a considerably greater potential producing capacity. This scheme of restriction in India is under the control of the India Tea Licensing Committee, which works under the International Tea Restriction Board located in London. The function of this body is not only to fix export quotas for various countries and tea estates there, but also to create new markets for tea. For this purpose the Tea Board has been brought into existence. It arranges for free supply of tea to expand its market and carries on an advertising campaign in favour of tea drinking. The activities of this Board are financed by a tax levied on all exports of tea from India. Owing to the activity of this Board in India the home consumption of tea has been rising.

As may be expected, the working of the restriction scheme has resulted in bringing into prominence certain economic considerations; such as the desirability of producing a large crop from a small area so as to reduce costs and also the production of the best quality owing to the limitation of the total crop. An experimental research station for tea exists at Toklai in Assam.

Recently, growing of shade trees amongst the tea plants has been started, because the tea under shade has a better cropping value than the tea away from shade. Several species of leguminous trees have been planted for this purpose.

During 1950-51 exports of tea were valued at Rs. 8,0 42 lakhs for ming 13.51% of the total value of exports from India. During 1957,

they amounted to Rs. 12,346 lakhs, forming 19.35% of the total Indian exports.

In 1962-63 there was an increase of Rs. 6.93 crores in the foreign exchange earned by exports of tea while in 1961-62 the value of tea exported from India was Rs. 129 crores and in 1960-61 it was Rs. 122 crores. Thus tea is an important foreign exchange earner being a traditional export item of India and occupying the second position.

Against the total quantities of tea produced in India, 201 million lbs. of tea were available for internal consumption during 1951-52, and 176.6 and 180 million lbs. during 1953-54 and 1954-55. In 1962 total production of tea was 758 million lbs. out of which 298 million lbs. were available for internal consumption and 460 million lbs. were exported to foreign countries.

The tea producing target for 1960-61 was 700 million lbs. out of which 470 to 500 million lbs. were to be exported.

The production and export target were reached in 1958 only. Third Five-Year Plan target of tea production for 1965-66 has been kept at 900 million lbs. annually, whereas export target has been fixed at 550 million lbs.

The Indian production of tea is the largest in the world, forming about 50%. This is about twice that of Ceylon, three times that of Indonesia and about four times that of Japan.

The effect of the two Great Wars has been to stimulate consderably the production of tea in India for British and other markets. Great Britain has, however, entered into an agreement with the Indian tea industry, whereby the prices charged from Britain will not be excessively high.

Quantity and value of tea exported from India to different countries during the years 1958 to 1963 :—

Year	Quantity (000 Kgs.)	Value (000 Rs.)
1958	229,503	13,65,377
1959	213,680	12,60,135
1960	193,063	11,99883
1961	206,293	12,42,513
1962	214,000	12,42,513
1963	223,542	13,23,710
1964	209,548	12,49,012

Problems of tea Industry

The problem of the tea industry is its enormous increase in the cost of production.

Recently a grave threat has been posed by India's competitors in tea exports such as East Africa, Ceylon and Japan *etc.* In the decade ending 1961 India's share in the world export of tea has dropped from 44.9% to 37.6% while the share of her competitors has increased correspondingly. Out of all Ceylon is the stiffest competitor. Her production and exports of tea have been steadily rising for the last five years whereas in India they have been fluctuating as may be clear from the following figures :

Ceylon (to the nearest million lbs.)

	1958	1959	1960	1961	1962
Production of tea	413	413	434	455	470
Exports ,,	411	383	410	426	451

Production and export figures of India have been given elsewhere in the preceding pages. The position will be clearer on comparing the figures of India and Ceylon.

So this is high time that suitable steps should be taken to boost up the production of Indian tea.

Drought is the main malady. A suggestion has been given to instal deep tube-wells to supply water during the dry periods particularly from November to April. But it is a very costly scheme.

Among the schemes under implementation for development and encouragement of the tea industry are the promotional activities in India and abroad of the Tea Board, loans granted to poorer gardens for repair and improvisation and renovation of plant and machinery, supply of machinery on hire-purchase basis, grant of transport subsidy in certain cases, supply of fertilizers to the gardens and research in the tea industry.

COFFEE

Coffee was brought to India in the early part of the seventeenth century by the East India Company who opened an experimental station at Anjarakandy near Tellichery in 1798. By 1840, the plantation spread to Chokmagalur and the neighbouring places. But in the mid-fi fties, the plantations spread to all the coffee growing areas which are the hilly tracts of South India.

Geographical conditions. The coffee tree requires heat, humidity, abundant rainfall, and a rich, well-drained soil. The principal coffee-growing regions have an average annual rainfall of about 135 to 140 cms. In a few areas coffee is grown with as little as 88 cms. of rain; in others, with as much as 154 cms.

The coffee tree tolerates neither frost nor drought. Daily rainfall followed by a strong sun when the berries are ripening and dry weather at harvest time are highly desirable.

Most coffee is grown where the average annual temperature is between 20 to 25°C. Although coffee requires a hot climate, in many regions the full blast of the sun is too hot for it, and high trees are scattered over many plantations to cast some shade.

The production of coffee which requires an altitude of 915 to 1220 metres above the sea level for its proper nurturing and atemperate climate in a tropical zone, is now mainly distributed between Mysore, Kerala and Madras while a small crop is also harvested in Andhra Pradesh. Andhra Pradesh has grown up from being the smallest of the three producers to a position of equality with Mysore which continues to be the largest producer of *Arabica* Coffee.

Although the coffee industry in India falls far short of the tea industry in the country, it is interesting to note that in Southern India it covers a larger cultivated area than either tea or rubber.

In 196°-61 'Coffee plantations' covered an area of over 2.95 lakh acres and production was 67,800 tonnes. Coffee production in 1961-62 was 45,700 tonnes and in 1962-63 it has been estimated to be 54,800 tonnes.

Breeding

The main problem in coffee breeding in India is the production of high-yielding varieties, their multiplication and distribution for cultivation over large areas as quickly as possible, so as to increase the level of production per unit area. As there is enormous variation in the coffee growing conditions in India, diversity is very great, and many varieties, each suited to particular conditions of soil, rainfall, *etc.*, are grown in southern parts of the country. The results of breeding for high yield have been spectacular in the country, and about 50 superior varieties, giving on an average 10 to 20 per cent better yield than the cultivatior's varieties have been evolved in different coffee-growing states of India.

The Arabica coffee thrived best in Mysore where rainfall averages about 180 to 400 cms. a year and where 21° to 32°C. temperatures prevail.

Over two lakh people drawn chiefly from Kerala, parts of Mysore and Madras are employed in the industry. Many of the coffee estates are inter-planted with orange trees, cardamom and pepper vines. There are only two types of coffee grown on commercial scale in India, the one most extensively cultivated being coffee Arabica and the best in quality, with Robusta coming next in importance. About 50 species and Sub-species of coffee are being grown in the coffee Board's research stations.

Coffee growing regions

Coffee cultivation is mainly confined to the hilly tracts of South India, from 305 to 1830 metres above the mean sea level, and is centred in the Malnad area of Mysore, Madras and Kerala. In lower elevations,

which have a higher rainfall, the more delicate but better quality *Arabica* coffee has given place to the harder but coarser *Robusta* coffee.

Coffee growing was established on a firm footing in Southern India in the last century, between 1830 and 1840, first in Mysore and then in Wynaad, Nilgiri and Shevaroi Hills. Later in 1854, the first coffee plantation in Coorg was opened from which a great expansion has taken place.

The coffee industry of India is confined to Southern India comprising Madras, Mysore, and Kerala. Of the total area under coffee Mysore accounts for more than half, and Madras and Kerala 22 p.c. each. The highest average yield per acre of plucked area is in Cochin and the lowest in Mysore.

In Mysore the plantations are mostly confined to the south and west especially in the districts of Kadur, Shimoga, Hassan and Mysore. In Madras the coffee plantations are found mostly in the south-west from North Arcot to Tinnevelly. Nilgiri is the important area. In Andhra it is grown in Vishakhapattam.

Area under cultivation

Total area under coffee cultivation in India is 114 thousand hectares. Nearly 50% of the cultivated area lies in Mysore and about 20% each in Kerala and Madras, while 5% in Andhra Pradesh and 5% in Andaman and Nicobar Islands. The following table LXIV shows the area under coffee cultivation in India.

TABLE LXIV : *Area in Thousand hectares*

Year	Arabica	Robusta	Total
1952-53	67.2	28.8	96.0
1953-54	67.6	30.8	98.4
1954-55	66.8	34.0	100.8
1955-56	64.8	36.8	101.6
1956-57	64.0	40.0	104.0
1957-58	65.6	41.6	107.2
1960-61	—	—	114
1964-65	—	—	N.A.

Coffee production

From the statistics we learn that out of the total production of 43000 tons of Coffee (both Arabica and Robusta) Mysore produced 54 per cent, Madras 36 per cent, Kerala 7 per cent, Andhra Pradesh and Andaman Islands 1.5 per cent each. The following table shows the production of Arabica and Robusta coffee in India.

TABLE LXX : *Production of Arabica and Robusta coffee in India*

Year	Arabica	Robusta	Total (million tons)
1950-51	15,511	3,382	18,893
1951-52	14,621	6,955	21,573
1952-53	12,944	10,999	23,943
1953-54	23,105	6,924	20,029
1954-55	16,425	9,002	25,427
1955-56	22,968	12,060	35,028
1956-57	29,872	12,700	42,572
1957-58	29,775	14,715	44,490
1958-59	25,580	21,335	46,915
1959-60	32,290	17,450	49,740
1960-61	39,445	28,575	68,020
1961-62	29,300	16,750	46,050
1962-63	33,825	22,100	55,925

Although India's coffee is claimed to be of the finest and best quality, India produces less than 1.5 per cent of the total world production, the biggest producer being Brazil with 60 per cent, Columbia 11 per cent, Indonesia 5 per cent. The biggest consumers are the U.S.A., Canada, Australia, and New Zealand.

Simultaneously as our production of coffee has been increasing, in 1960-61 it was nearly 43,000 tons, internal consumption has also expanded to over 20,000 tons. There is thus an exportable surplus of over 23,000 tons.

Trade of coffee

The principal markets for Indian coffee are the United Kingdom, France, Germany, Holland, Australia, Iraq and Belgium. Indian production of coffee is insignificant in comparison with the world production of coffee.

The Indian coffee crop gives, on an average, an yield of about 17,000 tons. The consumption of coffee in India has stepped up from 8,000 tons in 1940 to 35,000 tons in 1960-61 but recently it has again somewhat fallen down to 25,900 in 1961-62. Export of coffee has also increased from 8,000 metric tons in 1955-56 to 32,270 metric tons in 1960-61, although coming down to 19,830 m. tons in 1961-62. The coffee industry provides employments to over 2 lakh persons. India produces some of the best coffee in the world, and yet her exports are negligible, especially because of the competition from Costa Rica, British East

Africa and Columbia. The consumption of coffee in India is very low. About 96 percent of the coffee available for home consumption is consumed in Madras, Mysore and Kerala. The rest of the country consumes only 4 per cent.

The consumption of coffee in India has increased from 8,000 metric tons in 1940 to 35,000 metric tons in 1960-61 and out of crop about 20,000 metric tons of coffee was exported to foreign countries.

Increase in production has been followed by a rise in exports and internal consumption. The following table LXXI gives the trend of exports.

TABLE LXXI : *Trend of exports*

Year	Exports in metric tons
1953-54	9,767
1954-55	3,592
1955-56	8,082
1956-57	15,472
1957-58	14,281
1958-59	16,400
1959-60	20,600
1960-61	19,000
1961-62	29,700
1962-63	20,400

The coffee industry provides employment for over 2 lakh persons.

The Third Five-Year Plan targets of production and exports have been kept at 80,000 metric tons and 45,000 metric tons respectively.

Rubber

Rubber is a coherent elastic solid. Its physical properties are softness, toughness, elasticity, impermeability, adhesion, and electric resistance. Chemically, it is a hydrocarbon compound, extremely resistant to all but a few chemical elements. It is obtained from a milky liquid known as latex which is tapped from the bark of a wide variety of tropical trees.

Geographical Conditions

Rubber requires a hot climate. Most rubber is grown where the average annual temperature is not below 21 C. Heavy rainfall is necessary for its well growth. Daily rainfall followed by a strong sun is highly desirable. The rubber tree thrives in humidity and heat.

Soils must be rich and well drained. Some of the best rubber in Southern India and ceylon have rich loamy soils of volcanic origin. Rubber is grown at an elevations ranging from 300 to 450 metres.

Rubber agriculture had its beginnings in 1876 when Sir Henry Wickham brought Hevea seeds to Kew Gardens in London where he succeeded in germinating trees which he sent to Ceylon. Following this experiment, numerous plantations were begun in the British and Dutch Malaya Archipelago, which region long supplied most of the world's crude rubber needs. Rubber trees are set out about 100 to the acre and begin to yield latex in 5 to 7 years after planting.

Method of Extraction. The latex exudes from an incision in the bark and flows into an attached receptacle. Daily collections are made and the latex is brought to the estate factory where crude rubber is extracted. This consists of coagulating the latex, mechanically milling the doughy coagulum to remove most of the moisture, curing the sheets by smoking and drying.

The resulting product known as ribbed smoked sheets is then ready for use in the factory. Malay, Indonesia, Ceylon, British East Africa, Belgium ,Congo and South India to a lesser extent are the producers of the natural rubber, while the U.S.A., the U.S.S.R. and Germany have invented process for the manufacture of synthetic rubber—U.S.A. again is the largest consumer of natural rubber.

Rubber Growing Areas

Of an area of about 129 thousand hectares under rubber cultivation at the end of 1960-61, nearly 95 per cent is located in the State of Kerala, other rubber growing areas are the districts of Kanya Kumari, Coimbatore, Salem, Nilgiris, Madurai in Madras State and Coorg in Mysore State. The following table shows the statewise distribution of the planted area in India.

States	Area (hectares)
Kerala	70210.4
Madras	3811.2
Mysore	1486.8
Andamans	168.8

Nearly 75% of the cultivated area lies in Kerala and about 20% in Madras, while 3% in Mysore and 2% in Andaman and Nicobar Islands.

Production

Malaya and Indonesia share between them nearly eighty per cent of the total world output of natural rubber and since most of the rubber comes from the Sterling areas, London has been the marketing centre for the different consuming countries. India produces about 25,000 tons per year which is a little over one per cent of the total world production.

Production of rubber in 1950-51 was 14000 tons. The area under rubber during the same year was 58 thousand hectares. The average area under rubber during the year 1960-61 was 129 and production was 25,000 tons.

The following table shows the production and acreage of rubber.

Year	Acreage (thousand hectares)	Production (in 000 tons)
1950-51	58	14
1955-56	70	23
1960-61	129	25
1964-65	—	53

Plantations of tea, coffee and rubber cover less than 0.5 per cent of the cropped area, concentrated mainly in the valleys of the north east and along the coast on the South west of India. They provide employment to more than a million families and thus play a vital role in the economy of these regions. In addition, they earn for India many crores of foreign exchange. Tea alone accounts for Rupees 132 crores. A remarkable fact about tea plantations is that while the area under tea has remained unchanged for over a decade under international agreements, production has increased by about 24.7 per cent over this period. This incidentally brings out that where sufficient capital is invested, yields can be increased appreciably. Coffee and rubber, which used to be export commodities are now largely consumed within the country. India actually imported rubber from other countries, considerable quantities are being imported to meet the increased domestic demand of the manufacturing industry. Rubber occupies a key position in industrial development and for defence. The bulk of the area under rubber is comprised of small holdings which are on the whole comparatively less efficiently managed than the tea and coffee plantations.

Plantation crops, especially tea, coffee and rubber was given high priority in the third Plan period. The plan envisages increase in the export of tea from 465 to 550 million lbs. and more than two-fold increase in exports of coffee from the present level of 340,000 cwt. The consumption of rubber has increased rapidly in recent years and is now estimated at 53,000 tons. Requirements by the end of the Third Plan period was estimated at about 100,000 tons. The following table shows the estimated production during the Third Five Year Plan period.

Commodity	Base level production 1960-61	Target for additional production 1961-66	Estimated Production 1965-66	% in increase
Tea (thousand lbs.)	725	175	900	24.7
Coffee („ tons)	48	32	80	67.1
Rubber („ „)	26.4	18.6	45	70.5

QUESTIONS

1. Analyse the geographical conditions favouring the plantation agriculture in South India.

2. What geographical conditions favour the production of tea in India ? Discuss the international trade of tea.

3. Write an essay on the plantation agriculture in India with especial reference to Kerala and Assam.

4. Examine the possibility of considerable extension in the near future of Rubber growing in any one major potential area of Indian Republic.

CHAPTER 14
Fibrous Crops

COTTON

Until the partition, cotton was the most important commercial crop in India. Apart from providing materials for our cotton mills, it brought to the cultivator and others engaged in cotton trade crores of rupees from export. Raw cotton had the largest share, about one-fifth in our exports. It was pre-eminently a money crop for the Indian cultivator.

After the partition, however, India is no longer self-sufficient in raw cotton, and it has lost its importance in the export trade. Mainly because our own textile mills now need more raw cotton owing to their rapid progress during the war.

Owing to rapid agricultural advance in China and the U.S.S.R., now India has been pushed down to the fourth place among cotton producing countries of the world, as may be evident from the following table :—

World Production of Cotton (ginned) in

1960-61 *(in thousand metric tons)*

U.S.A.	3107
China (mainland)	2410
U.S.S.R.	1482
India	959
Mexico	437
United Arab Republic (Egypt)	478
Brazil	483
Pakistan	304
Turkey	176
Iran	89

The area under cotton in India in 1960-61 was 7.6 million hectares and the production about 53,94,000 bales.

The comparative importance of cotton is greater in Bombay and Madhya Pradesh where before the war it occupied 19 to 20 p.c. of the total net cultivated area, than in other States, say for example, U. P., where the percentage was only about 1. Even in the Punjab, cotton occupied only 9 p.c. of the total net cultivated area of the province. Apart from the competition offered to cotton by other commercial crops, soil well suited to cotton is not easily found outside Black Cotton Soil region. This fact is largely responsible for the varying importance of cotton in different States of India.

A reference to the cotton map, and its comparison with the soil map will show that the cultivation of cotton in India is closely related to the 'regur soil' (or the Black Cotton Soil). The largest concentration of the crop occurs in Broach, Khandesh, Berar and Tinnevelly, all in the Deccan tableland. Outside the Deccan tableland the crop is found concentrated, though not to the same extent, in the Punjab. This latter area is, however, essentially an irrigated cotton tract. More than two-thirds of the crop is found in the States of Andhra, Maharashtra, Gujarat, Madhya Pradesh and Madras, and only one-fourth in the alluvial plains of the north. This shows to what an extent the Black Cotton Soil and the associated soils are a boon to the cultivator of the Deccan table-land in producing this money crop.

Geographical Conditions

The soil is the dominant factor in the cultivation of cotton in India.

There are three main classes of cotton soils here :—

(1) Rich black loamy soils, as those of Kathiawar, Gujrat, Khandesh or Karnatak. These are collectively known as the 'Black Cotton Soils'.

(2) Mixed red and black stony soils, as those of the Deccan, Berar and Madhya Pradesh.

(3) Alluvial sandy soils, as those of the Sutlej-Ganga Basin. Climate is the next important factor in the cultivation of cotton in India. An idea of the suitable climate is given by the following graph :—

Three things stand out prominently in the study of this graph:—

(a) The period of growth of cotton, from July to September, is marked by uniformly high temperatures, between 21° and 30°C.

(b) The period of high temperatures is accompanied by high humidity, generally 80%.

The combination of great heat and great humidity is particularly helpful for the growth of the cotton plant.

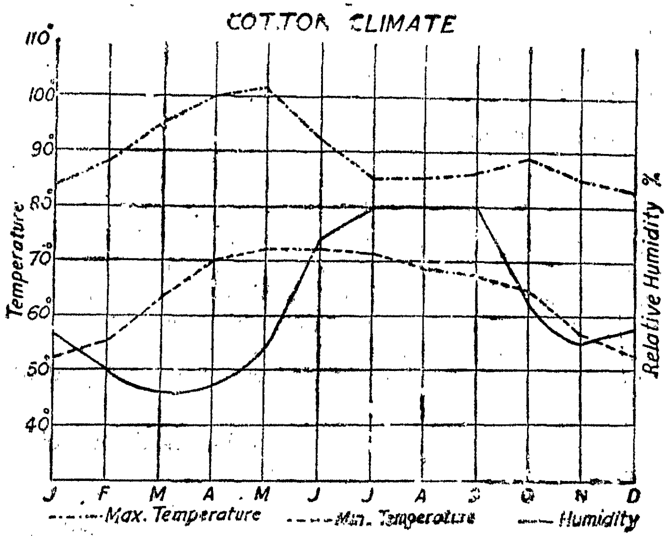


Fig. 34. Meteorological Observation at Ahmedabad.

(c) From about October humidity falls off considerably, but the maximum or the day-temperature continues to be above 26° F. This factor helps the ripening and bursting of the cotton bolls in the sunny skies that result.

It is also clear from the graph that from the month of March onwards the temperature conditions are suitable for cotton cultivation in India, but the moisture is deficient as is shown by the downward curve of relative humidity.

The influence of rainfall and the amount as well as the season when it comes, is of vital importance in the cultivation of cotton. If the rainfall is considerable no cotton will be cultivated, even if the soil is suitable. For it encourages vegetative growth rather than fruit from which cotton is obtained.

Cotton is a crop which demands a very great amount of hand labour, and in order not to unduly enhance the cost of production, such labour needs to be both abundant and cheap. Sowing which may last some weeks is followed by a long period of very careful cultivation to ensure the best results. Picking, which may begin in India as early as last week of December, is a long process which may be, and commonly is, spread over a period of about three months.

Southern India, with its two rainy seasons possesses two widely different cotton crops.

A reference to the rainfall map will show that most of the cotton in India is grown in areas which have a rainfall of 30 to 76 cms. per year. The picking season over the main cotton-growing area, that is, from November to February, is practically dry.

Cotton growing areas

The cotton areas in the country can be broadly grouped into the following three regions according to Cotton Cropping season.

1. *Central and Western Zone.* This area, which comprises western district of Madhya Pradesh, Maharashtra, Gujarat and some parts of Andhra Pradesh, has the highest intensity of Cotton cultivation in the country. The main cotton season is from August-September to March-April, when the most important cotton crop of the region, *i.e.*, the crop known as Omras in Maharashtra and Madhya Pradesh, is a long and medium variety.

The most favoured localities for growing the finest Indian cottons are Surat, Broach, Ahmedabad and Kathiawar.

The main areas for cotton cultivation in Maharashtra and Gujarat are Ahmedabad, Broach, Surat, Karnatak, Dharwar and Khandesh. In Broach, the soil is deep and retentive of moisture. The 'Black Cotton Soil' in some parts is about 1½ m. deep. Over the greater part the annual rainfall exceeds 35 inches (90 cms.). The crop is sown as soon as possible after the monsoon sets in. It is grown alone, but where the rainfall is heavy and the soil retentive (as in Broach) rice is grown with it. The principal associated crop with cotton is, however, Jowar. The flowering begins in October-November and the picking generally starts in January, lasting till March or April.

The cultivation is slightly modified due to the monsoon in Karnatak, Dharwar and Khandesh. If sowings were done in June, as in other districts, the crop would ripen here in the middle of the north-east monsoon and be damaged by rain. To prevent this, sowing usually starts in the latter part of August.

In Khandesh two different types of cotton are grown, the one on the heavy black soil and the other on light soil. The light soil crop yields best with heavy rainfall, and the black soil crop with moderate rainfall.

In Madhya Pradesh sowing of cotton commences with the rains in June. Picking starts in November and is finished by March.

2. *South Eastern Region.* This area, comprising the deltaic tracts of the Cauvery and non-deltaic rain-fed areas of Madras has two cotton growing seasons.

There are two forms of indigenous cotton usually grown in Madras, one depending on the south-monsoon, the other on the north-east. The former crop is sown between May and July, and the latter between

September and November. In Tinnevelly both are sown in the same season, October to November. In the Tamil country where cotton is produced both on black soil and red soil, the crop is sown in black soil during the south-west monsoon when the rainfall is not heavy; and in the red soil, which is a lighter soil, during the north-east monsoon when the rainfall is heavy.

3. *North Western Region.* This area comprising Bihar, Uttar Pradesh, Punjab and Rajasthan, has low winter temperatures, and only crop of cotton can be grown from March-August to January-March.

Outside the Peninsula irrigation plays an important part in cotton cultivation. Sowing of the crop does not, therefore, wait for the rains in the areas where irrigation facilities are available. In areas where such facilities are not present, however, the sowing can be done only with rains. The period of sowing thus varies from March to August. In the Punjab, owing to the danger of frosts, the picking is completed by about January.

In Uttar Pradesh, too, cotton production is almost entirely dependent upon irrigation. In this state cotton is usually grown in rotation with wheat. In U.P. the most important districts producing cotton are Saharanpur, Muzaffarnagar, Meerut, Bijnor, Moradabad, Bulandshahr, Aligarh, Mathura, Agra, Mainpuri, Etah, Etawah, Kanpur, Rampur, Nainital, Bareilly etc.

Among the indigenous varieties of cotton grown in India, the Broach cotton is the best. The Broach tract extends north-wards from the river Par up to the southern boundary of Ahmedabad district. It is one of the most important cotton tracts of India and at one time was the most important. It has now lost its importance considerably owing to the infiltration of important varieties which are: Omras, grown in Berar, Dholeras ties Broach cotton yields the finest and the longest fibre. Other important varieties are Omras, grown in Berar, Dholeras grown in Gujarat, Dharwar grown in southern Bombay States and the Bengal, inferior to all, grown in Northern India. Practically all the indigenous varieties have a short and coarse staple. Certain types of cotton have been imported from foreign countries and crossed with Indian varieties to produce better varieties yielding finer and longer staple. Among these improved cotton may be mentioned the Combodias grown in south-east Madras, and Punjab-Americans grown in south-west Punjab. With the growing demand for finer cottons in India, all efforts are being made to improve the quality.

Area Under Cultivation

The area under cotton in 1958-59 was 79.6 lakh hectares, in 1960-61, 75.2 lakh hectares and in 1961-62, 74.8 lakh hectares. The production of cotton (lint) was 46.8 lakh bales in 1958-59, 53.9 lakh bales in 1961-62. The II Five Year Plan target of cotton production was 65 lakh bales which has not been achieved even till now.

The average area under cotton cultivation during 1950-51 was 5,882 thousand hectares. The highest acreage was recorded in 1955-56 when it reached a peak of 8,086 thousand hectares. The year 1964-65 sad a further increase in acreage reaching a new height of 8,154 thousand hectatres. The trend of acreage is given in table LXXII.

TABLE LXXII : *Acreage in Cotton Cultivation.*

Year	Area (in thousand hec.)
1950-51	5882 ,,
1955-56	8086 ,,
1960-61	7610 ,,
1964-65	8154 ,,

Within the Indian Republic, Maharashtra stands out predominantly in acreage followed by Gujarat, Mysore, Madhya Pradesh, Madras, Punjab, Andhra Pradesh, Rajasthan, Uttar Pradesh, Assam and Tripura, as seen from table LXXIII.

TABLE LXXIII : *Acreage under Cotton in different States in India.*

State	Acreage (thousand hectares)	Production (thousand bales)	Yield per .4 hectare (lbs.)
Andhra Pradesh	398.0	132	54
Assam	14.0		
Bengal	(a)		
Bihar	2.8		
Gujarat	1808.4		
Kerala	8.8		
Madhya Pradesh	793.2	397	80
Madras	408.4	356	124
Maharashtra	2586.8		
Mysore	1064.0	425	66
Orissa	9.2		
Punjab	608.8	711	187
Rajasthan	232.4	147	93
Uttar Pradesh	79.2	34	98
Delhi	.4		
Himachal Pradesh	.4		
Tripura	7.6		

Cotton in India is bought and sold, in common with many other agricultural products, on the reputation for quality of its place of growth. The difference in quality of cotton that exists between the same or different types of cotton grown in different tracts has always been a source of temptation to unscrupulous people. Measures have been taken under the above act, and other acts, to eradicate inferior cottons from certain protected zones. There are now seven such zones in Bombay, two in the Madras State and one in Madhya Pradesh.

The average yield of cleaned cotton per acre in India is very low, only about 96 lbs. per acre. This is very low when compared with the Egyptian average of over 496 lbs. and the American average of over 46.6 lbs.

The following table shows the acreage, production and yield of cotton in some selected countries of the World.

TABLE LXXIV : *Acreage, Production and Yield of Cotton*

Country	Acreage thousand hectraes	Production thousand bales	Yield per 4 hectares
India	8154	4075	96
U.S.A.	6771	11500	466
China	4000	10000	322
U.S.S.R.	2040	6900	621
Pakistan	1414	1270	184
Mexico	1036	2340	450
Egypt	754	2057	497
Sudan	239	585	316
Peru	237	500	412

It is seen that the yield of irrigated cotton is much better than that of unirrigated cotton. In Madras, for example, the average yield of irrigated cotton is 250 lbs. per acre while that of unirrigated cotton is only 73 lbs. Most of the cotton crop in India is, however, unirrigated. The largest cotton acreage irrigated is outside the chief cotton zone. Practically no cotton grown in the Black Cotton Soil region is irrigated. The largest area of irrigated cotton is in the Punjab, South-eastern Madras and U.P.

An important point about cotton cultivation in India is that the cotton fields, unlike those in America or Egypt, in a large majority, produce a grain crop after cotton has been harvested. The field is, therefore, cleared before all the cotton has been picked. The total outturn is affected adversely in years in which the monsoon rains start late. For it must be borne in mind that the sowing of indigenous crop in Black Cotton Soil area particularly, and elsewhere generally, is done

with the first monsoon rains. A large proportion of the buds (bolls) of improved variety which produce longer staple, as well as of the indigenous cottons, never get a chance to open, owing to the falling off of temperatures in December. The Black Cotton Soil area and the South generally have an advantage in this respect. There the winters are warm with bright sunshine and cotton picking goes on during winter and even up to July in some cases.

COTTON

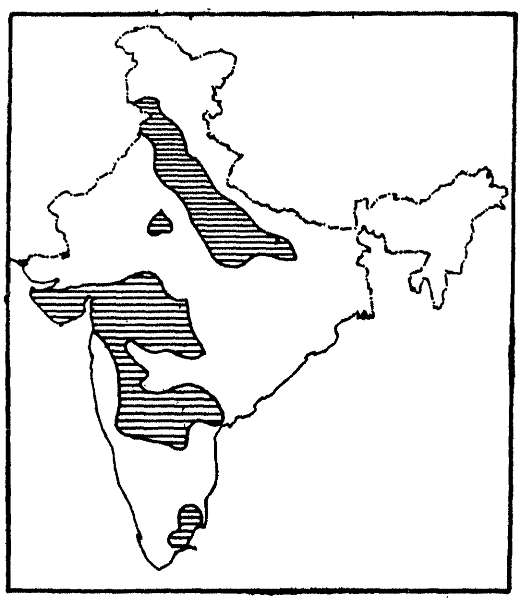


Fig. 35. Cotton growing areas

Production

The production of cotton in 1959-60 was 4075 thousand bales of which U.S.S.R. produced 6900 thousand bales. Production of China during the same year was estimated at 10000 thousand bales, 27% of the World's production and second highest in any country. India which had the higher acreage, accounted for 1.5% of the world production. The other important cotton producing area like U.S.A., U.S.S.R., Pakistan, Egypt, Sudan, Mexico, Peru etc., jointly accounted for 80 per cent. of the world output.

India has fairly increased her overall cotton production in recent years, is evident from the following table LXXV of cotton production.

TABLE LXXV. *Cotton Production in India.*

Year	Production (000 bales)
1950-51	2875
1955-56	3949
1960-61	5293
1964-65	5408

The production of cotton at the end of Second Five Year Plan was anticipated to be 5.4 million bales *i.e.*, 1.1 million bales short of the target. The average production of cotton in India for the quinquennium for 1965-66 was 6.1 million bales, representing an increase of about 13.7 per cent over 1960-61.

Since the beginning of the present century the home consumption of raw cotton in India has been increasing. The average consumption of Indian cotton in Indian mills during the period from 1937-38, 1955-56 was about 27 lakh bales. In 1950-51 this consumption was 36 lakh bales and 49.6 lakh bales in 1958. The greater part of this consumption is of long and medium staple cottons.

The following table gives the consumption of cotton (Indian and foreign) by the Indian mills :—

(*In million bales of* 400 *lbs. each*)

Year			Indian Cotton	Foreign Cotton	Total
1946-47	..	..	2.14	1.72	3.86
1948-49	..	..	2.12	1.13	4.25
1951-52	..	..	2.99	1.08	4.07
1954-55	..	..	4.14	0.63	4.77
1955-56	..	..	4.37	0.60	4.97
1957-58	..	..	4.69	0.56	5.26
1958-59	..	..	4.62	0.45	5.07
1962-63[1]	..	..	54.74	6.07	60.81

Trade

Although the United States is the world's leading producer of cotton, it buys some of our cotton. The United States does not grow the rough, white short-staple cotton used for manufacturing cotton and mixed cotton-wool blankets. Some American cotton is used for the manufacture of cotton blankets, but it is admitted to be not as suitable for this particular purpose as the imported Indian cotton. Moreover,

1 lakh bales

American cotton, unlike the rough short staple cotton does not mix with wool, and therefore, does not lend itself to the manufacture of cotton-wool blankets which are popular in those parts of the United States where the temperate climate precludes the use of all-wool blankets. Indian cotton is also used to a comparatively small extent as padding in clothing.

The important qualities of short-staple cotton imported into the U.S.A., are its roughness, cleanliness and whiteness. Until recently, China, (especially North China), and India were the two main sources of supply. The Far Eastern hostilities, however, led to the practical elimination of China as a source of supply. This considerably improved the position of Indian short-staple cotton in the United States during the war.

India exported Rs. 2120 lakh and Rs. 1637 lakh worth of raw cotton (Short-stapled) to foreign countries in 1958 and 1959 respectively. This was sent mainly to U.S.A.

India also has to import cotton (long stapled) from U.S.A. (and Egypt for the manufacture of fine cloths. In 1958 India imported Rs. 3066 lakh worth of raw cotton and in 1959 Rs. 3476 lakh worth, from foreign countries.

JUTE

India has suffered most in the supply of jute due to partition than cotton, the other fibre crop. Out of the 23 lakh acres under jute in India in 1947, more than 18 lakhs went to Pakistan. The best districts for jute, Mymensingh, Dacca, Rangpur, Bogra and Pabna all bordering on the Brahmaputra and affected by its floods, which deposit large quantities of fertile silt, now form part of Pakistan. The result has been that in 1951-52 while Pakistan produced about 68 lakh bales, India produced only about 46 lakh bales. The old Brahmaputra or the Jamuna in Pakistan also provides clearer water for retting the jute than the Ganga. The cultivation of jute decreases towards the south in the Ganga Delta where the land is too low for jute, and towards the west where the rocky ground of the Deccan plateau is more marked than the Ganga alluvium.

The production of Jute in the following provinces is as follows.

		55-56	58-59	59-60	60-61	63-64[1]
Assam	..	1,212	986	1114	813	1028
Bihar	..	589	1,243	956	839	949
Orissa	..	245	177	212	261	471
U.P.	..	89	95	92	89	141
W. Bengal	..	2,013	2,596	2,170	1,987	3,352
Tripura	..	50	58	60	41	72

(production in thousand bales)

1. Production in thousand bales metric tons.

Climatic Conditions

Jute is generally grown on raised ground provided by the old or new river levels. In the depressions rice and jute are often rotated. The best quality of jute is obtained from loamy soils. Clayey soils give the heaviest yield, but the plants grown in such soil do not ret uniformly. Sandy soils, on the other hand, produce coarse fibre.

In Bengal there are old and new alluvium soils which are called *lal mati* or *khiar* and *pili mati* respectively, the same as *Bhangar* and *khadar* in Bihar and Uttar Pradesh. The new alluvium is generally found near large rivers, especially in their deltas and is commonly called alluvial soil *par excellence.* The soils of parts of Orissa, South Bihar and Burdwan division belong to old alluvium. The whole of North Bihar, West Bengal and North Bengal consists of new alluvium, with the exception of Madhupur and the Khiar in North Bengal. Jute grows on new alluvium, but not on the old. Khiar land becomes very hard in a drought and prevents the spread of the roots of the jute plant. This seems to be the chief reason why it is so unsuitable for this crop.

Jute grows to perfection on loamy soils. The rain water sinks quickly into loamy soil; hence loamy soil is preferred to stiff clay, which can neither absorb nor part with its water as readily as loam or sandy loam does. On clayey soil it yields a fibre which is sticky, more or less, while a coarse fibre is obtained from sandy lands. Jute is vey badly affected by water logging when it is young.

It is well known that when a soil contains soluble salts in quantities above a certain amount, it is unfit for any crop. Even Saltpetre, if present in the soil water in a too concentrated form, acts as poison for plants. Dr. Voelcker's experiments show that no crops on soils (Surface soil) which contain .2 per cent of Soda, .4 per cent of common Salt, or .7 per cent of Sodium Sulphate.

Jute grows on the high lands as well as on the low lands, which are not liable to submersion before the middle of June. Floods cannot do much harm to the plants once they are sufficiently strong, that is, when they will shortly run to flower. Of course, highland Jute is always superior to lowland jute in quality.

Climatic conditions are, however, of more value to jute than the composition of the soil. A hot damp climate, in which there is not too much actual rain, especially in the early part of the season, seems to be best for it.

Jute is a rainy-season crop. Damp heat is the most favourable for its growth. Excessive rain, saturating the soil with moisture, delays both sowing of the seed and the after treatments.

From one to three inches of rain distributed in a month, during sowing period, may be considered sufficient. Occasional showers of rain, varying from 2 to 3 cms., at intervals of about a week, are most beneficial for the growth of the plants.

18

The temperature of atmosphere on the tracts where Jute is grown hardly exceeds, during the growing season, 37°C. and falls below 15°C. Humidity varies from 69 to 91. It is not possible to grow jute anywhere in Bengal during the cold weather.

The table LXXVI below shows the normal maximum and minimum temperature of the air, the mean humidity and the normal rainfalls recorded at some typical stations in the jute growing areas—

TABLE LXXVI : *Meteorological observation in Jute Growing Areas.*

Month	Weather Conditions	Calcutta	Dinajpur	Gauhati	Silchar
	Minimum temperature C.	14	9	12	13
	Maximum „ C.	40	36	40	36
March	Humidity	80	65	75	80
	Rainfall	2.5	2.5	5.0	20.3
	Min. temperature C.	21	18	19	16
April	Max. „ C.	40	38	32	33
	Humidity	79	81	84	87
	Rainfall	5.0	5.0	15.2	37.9
May	Min. temp. C.	21	19	18	19
	Max. temp. C.	40	42	35	36
	Humidity	81	72	81	85
	Rainfall	15.2	17.7	22.8	37.2
June	Min. Temp. C.	24	21	2	22
	Max. Temp. C.	36	35	35	37
	Humidity	87	88	82	88
	Rainfall	27.9	45.0	37.1	55
July	Mini. Temp. C.	23	21	22	22
	Max. Temp. C.	35	35	35	38
	Humidity	89	91	83	91
	Rainfall	32.8	37.9	25.4	49.4
Aug.	Min. Temp. C.	23	23	24	19
	Max. Temp. C.	32	33	35	36
	Humidity	89	91	86	91
	Rainfall	30.4	32.9	22.8	50.8
Sept.	Min. Temp. C.	23	23	23	22
	Max. Temp. C.	33	33	33	34
	Humidity	90	89	83	90
	Rainfall	25.4	30.4	15.2	32.9

The maximum temperature of water in which jute is steeped should be about 26°C. The rainfalls appear to be too heavy in Silchar for the Jute crop.

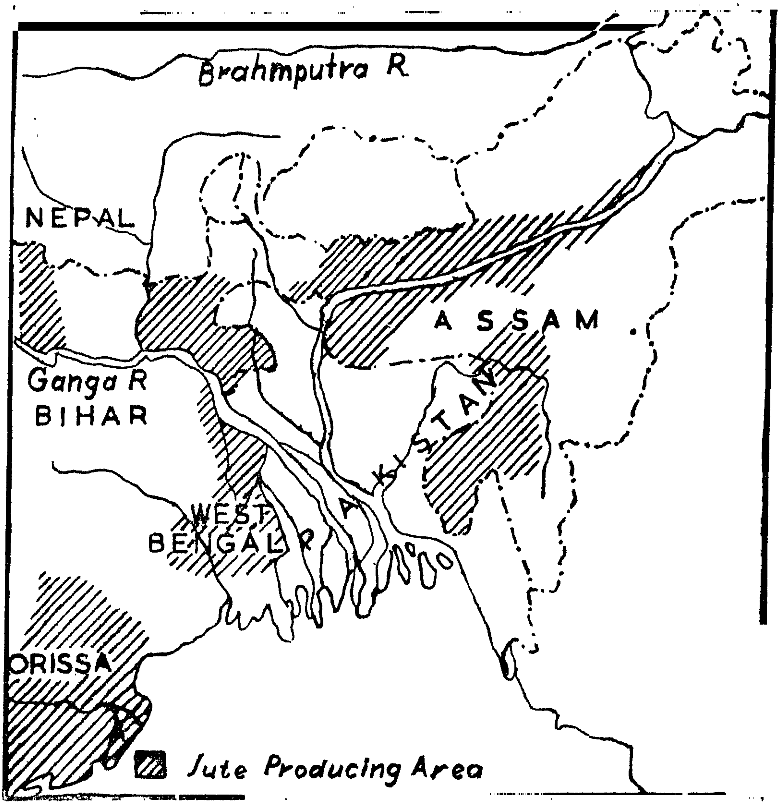


Fig. 36. Location of Jute Mills along Hooglyriver in West Benlga.

There are two main varieties of jute plant grown in India; Chinese and Indian. The Chinese variety is chiefly grown on *CHARS* or mud-banks and islands formed by the rivers. The Indian variety grows chiefly on BIL or completely submerged lands even on salt-impregnated soils, such as those of Sunderbans. These varieties are, however, found growing together in many parts of India.

The character of the land, whether it is upland or lowland, determines the sowing period of jute. When it is to be grown on lowlands, subjected to flooding, sowing takes place earlier than on raised land. Thus, on BIL lands it is sown from February to March and on raised land from March to June. The time for harvest depends largely on whether the crop is an early sown or late sown. The harvesting season starts for the earliest crop about June; the average season from all crops being August to the end of September.

The districts which have a heavy annual deposit of silt have a superiority over others which have little or no silt deposit, especially because manuring is not commonly practised in jute cultivation.

Jute-producing Areas

India had a world monopoly of jute before partition. It must be remembered that the largest consumption of jute is for packing material. Cheapness, durability and strength are not found in any other packing material as in jute. To increase the supply of raw jute in India the area under jute is increased.

The main areas for jute cultivation are in West Bengal, Assam, Bihar, Orissa, Uttar Pradesh and Tripura. At present, jute is extensively cultivated in the Districts of Golpara, Kamrup, Darrang, Nowgone, Garo Hills and Sibsagar in Assam State.

In West Bengal most important districts producing jute are Murshidabad, west Dinajpur, Cooch Bihar, Nadia, Burdwan, Malda and Midnapore.

In Bihar the important jute-producing districts are Purnea, Saharsa and Darbhanga. There are, however, small areas of jute cultivation spread all over the Terai region of Northern India. Jute is very widely grown in Coastal districts of Orissa. Jute is also grown in Kerala on experimental basis, because its climate and soil is ideally suited for jute cultivation.

Area under cultivation

Total area under jute cultivation in the Indian Republic is 841 thousand hectares (1964). Jute has the largest area in West Bengal about 52.6% followed by Bihar 22.1%, Assam 15.5%, Orissa 6.2%, Uttar Pradesh 2.2% and Tripura 1.4%. The following table LXXVII shows the area under cultivation in different states of India.

TABLE LXXVII : *Area under cultivation*

State	Area (hectares)	
	1962-63	1964-65
Assam	134.0	133.6
Bengal	430.0	447.6
Bihar	180.0	192.8
Orissa	48.4	54.0
U. P.	20.8	19.2
Tripura	12.0	7.6

Jute production

In 1950-51 the production of jute in India was 33,09,000 bales. The highest production was recorded in 1955-56 when it reached a peak

of 42,32,000 bales. The year 1964-65 saw a further increase in production reaching a new height of 60,79,000 bales. The following table LXXVIII shows the production of jute since 1960-51.

TABLE LXXVIII : *Jute Production*

Year	Production
1950-51	3309
1955-56	4232
1960-61	4134
1964-65	6079

Within the Indian Republic, Bengal Stands out predominantly in production followed by Assam, Bihar, Orissa, Uttar Pradesh and Tripura, as seen from table LXXIX.

TABLE LXXIX : *Production of Jute in different States in Indian Union.*

State	Production (metric thousand tons) 1962-63	1963-64
Assam	2870	1028
Bengal	3153	3352
Bihar	1052	942
Orissa	312	471
U. P.	154	141
Tripura	91	72

Trade of Jute

For the year 1961-62 India exported a sizable amount of jute manufactures to various countries of the world and earned foreign exchange to the tune of Rs. 1403 million. Main exporters were U.S.A., Canada, United Kingdom, Argentina, U.S.S.R., Egypt, Australia etc., who have preference for the Indian jute. Following is the percentage of Jute exports—

U.S.A.	36.6%
Canada	5.5%
U. K.	4.7%
Argentina	3.3%
U. S. S. R.	2.9%
Bahrein Isles	2.1%
Egypt	1.5%
Australia	1.4%
Others	2.0%

The following table LXXX shows the exports of Jute since 1955.

TABLE LXXX : *Export of Jute (thousand tons)*

1955-56	860
1956-57	864
1957-58	805
1958-59	829
1959-60	865
1060-61	765
1961-62	795
1962-63	880
1963-64	950

The Union Government have decided to fix the Fourth Plan target at ten million bales (eight million bales for jute and two million for Mesta) against the Third Plan's 7.5 million bales. The additional production of nearly two million bales is sought to be achieved partly through an addition of 200,000 acres or 80000.0 hectares by double cropping in canal and tube-well irrigated areas, but mainly through an increase in the unit yield from the present 2.8 bales to 3.3 bales by the intensification of development measures selected jute growing areas.

Jute is grown in India in 73 districts, but instead of diffusing efforts and investments over all the jute growing areas, the objective in the Fourth Plan will be to concentrate attention on only 14 districts, each of which has a fairly high spread of jute cultivation and all of which together account for over 80 per cent of the country's total production. The 14 districts are 24 Parganas, Hooghly, Nadia, Jalpaguri, Cooch-Behar, Murshidabad, Malda and West Dinajpur in West Bengal, Purnea and Saharsa in Bihar, Goalpara, Nowgong and Kamrup in Assam and Tripura.

In order to improve the quality of jute the Government envisages the setting up of 18 state farms for the production of good quality seeds, of which 3 are to be in West Bengal, 3 in Bihar and 1 each in U.P. and Orissa.

In view of the dearth all over the jute growing states of retting water which constitutes singly the most important factor in influencing the quality of jute fibre, the Government of India has accepted the three-year Scheme for Constructing 8200 new tanks and reexcavating 4300 old tanks.

QUESTIONS

1. Under what geographical conditions are Cotton and Jute grown in India ? Mention important areas of their cultivation. (Agra. 1959.)

2. Analyse the geographical conditions favouring the cultivation of Cotton and Jute in India. (A. U., 1965.)

3. Examine the possibility of considerable extension in the near future of cotton-growing in any one major potential area of India.

4. State the changes that have taken place in the distribution of cotton or jute cultivation in India in recent years. Examine the possibilities maintaining her position as an exporter of cotton or jute in view of these changes.

CHAPTER 15
Horticulture

The development of Horticulture is the only way for solving the economic condition of the vast peasantry of India and the growing unemployment among both educated and uneducated masses of this vast region since crop husbandry has proved uneconomical in most of the areas. The condition of the bearing orchards is very missable, the average yield per tree or per hectare is much below the average standard of advanced countries. It is because some of their basic problems are entirely different from those of other countries mainly due to varying soil, climatic and topographical conditions.

Fruit Production

A wide variety of fruits and vegetables is cultivated in the country. The total area under all fruit at present is about 1.2 million hectares.

Horticulture

The cultivation of fruits and vegetables does not form an important part of the Indian agriculture. Hardly 2 p.c. of the total net area sown in India is under fruits and vegetables. By far the largest proportion of this area lies in the Ganga-Brahmaputra Basin. It increases as one proceeds down the Ganga. U. P. has about 1 p. c. of its total net area sown, under vegetables and fruits, but Bihar has 2.5 p.c., Bengal 3 p.c. and Assam 6.5 p.c.

Fruits are grown in many climate regions, although not in such high latitudes and altitude as other crops or vegetables. The table LXXXI given below shows the following fruits suitable for different altitudes.

The fruit crops of India may be classified geographically as follows—

(1) those of temperate region and

(2) those of the sub-tropical regions.

Although many kinds of fruits are grown in temperate regions of India, the most important include the Apple, peach, pear, grape, plums and strawberry.

TABLE LXXXI : *Selection of fruits suitable for different altitudes.*

Operation	Apples	Peaches	Apricots	Plums	Pears	Cherries
Site and Soil	Mostly grown at 1828 to 2743 m. Sandy and sandy loam soils should be avoided because they do induce root borer attack and pink disease. The most suitable soil is deep and heavy loam which can retain moisture during day periods.	Do well at 1219 to 2133 m. Loam and sandy loam soil which can retain moisture are the best. Heavy clay soil should be avoided.	Do well in lower altitudes up to 914 to 1614 m. But not above 1828 m. The soil requirement is the same as for peach. No specific aspect is needed. Apricot plants can stand drought better than peaches.	Do best at 1219 to 2133 m. Loam and sandy soil which can retain moisture are the best.	Do well at 1828 to 2700 m. Sandy and sandy loam soils are not suitable because they induce borer attack and pink disease. Fairly deep and heavy loam are ordinarily preferred for pears.	Do best at 1828 to 2700 m. Northern aspect is essential. Should be planted on ridges and exposed situations or under forests. Otherwise, the fruits will be damaged by birds. Sandy loam and loam which can retain sufficient moisture are suitable.

Diverse types of fruits are cultivated in sub-tropical region, but orange, grapefruit and lemon are the most common. Figs, lichi, loquat, water melon, waterchestnut etc., are also important. Many true tropical fruits such as mango, pine-apple etc., are also grown on a commercial scale in the sub-tropical regions of India.

In India there are more species of fruits in the temperate regions than in any other region, but most of them are of local importance and because of their high perishable nature do not enter into national commerce.

APPLE

The apple is the most important fruit of temperate climate. The tree itself is quite resistant to low temperature and adapted to a wide range of climate and soil conditions.

The apples are grown in the drier and cooler parts of the Himalayas, especially near the Punjab. The Kulu, Kashmir valleys, Almora, Nainital, Garhwal, Tehri Garhwal and Uttarakhand divisions are the most famous. In Kumaun, apple is extensively cultivated in Muktashwar, Bhowali, Ramgarh, Doonagiri, Dwarhat, Kapkot etc.

PEACH

The peach tree, unlike apple, yields well only in restricted localities and under special climatic conditions. It is more subject to early spring frost and to winter killing of the buds than is the apple. Owing to the difference in seasons, peaches are transported from Kumaon and Kashmir in June to October.

The dedicious fruit is regarded as more of a luxury than the apple, chiefly because of its perishable nature it is less adopted to being a staple item of commerce. The standard market peaches cannot be kept in good condition more than fifteen days or three weaks without excessive cost, while some varieties of apples will keep in storage from October until June.

The main areas for peach cultivation in Kumaon and Uttarakhand are Nainital, Almora, Garhwal, Pithoragarh and Chamoli.

In Himachal Pradesh, as in Kumaon, the peach does best in the temperate climate region. Kangra provides half, with Kulu and Sima another quarter of Himachal Pradesh's production.

Peaches of excellent quality are grown in Punjab, Hariyana, Jammu and Kashmir, but chiefly for home consumption. Small quantities are exported to Southern markets in August to October, but this is a limited luxury market due to the transport costs and lack of communication.

PEARS

The most important fruit in Kashmir, Kumaon and Himachal Pradesh is Pears. The fruit is of the greatest relative importance in

such cold, humid areas as Kashmir, Kulu and Kumaon, and is grown to a great extent also by the people of the Nilgiri hills. In Kumaon it does well from Almora to Nainital, and two localities have utilized their special advantages for developing the pears as a money crop. The most famous pears district in Kumaon is Nainital. Karmi is noted for its pears and fruit. This is the most northerly point of the Almora district where pears cultivation is important. Peach is also cultivated, but the greatest acreage is devoted to Pears. Because of the amount of sunshine, the length of the summer days, and the people afforded by the hills to the north, this is the most important fruit growing region in Kumaon. Other pears growing places are Ranikhet, Chaubatia, Bhimtal, Ramgarh, Hawalbag, Doonagiri, Bhowali etc.

The topography of Kashmir and Himachal Pradesh aids horticulture. The general slope of the Highlands is from the east to west where the old rocks dip under the newer and less resistant rocks of the south. Because of their altitude the High lands have cold winters and cool summers, the rainfall is moderate. In addition to these is a high percentage of cloudiness, and mists are common. The rainfall decreases rapidly northwards. There are few natural resources, no mineral wealth, and the old hard rock yields only a thin soil which is usually infertile. Moreover, the climatic conditions do not favour agriculture, and communication are generally difficult. Occasional shepherd huts are the only signs of habitation. In the valleys there is some horticultural farming, cattle and sheep are reared, and crops of pears, apple, apricots, walnut, pomegranate, mulberry, almond, grapes etc., are raised. In some places, these are not, as a rule, money crops, only sufficient being grown to satisfy the needs of the local population.

APRICOT

Apricots are grown in the temperate regions of India, where rainfall is plentiful; humid nights and an annual rainfall of 130 to 205 cms. For its best development the Apricot requires cool weather during the early part of its growing period and moderately high temperatures during the latter part. During its early growth it also requires an abundance of moisture. At present time apricots are grown in all the temperate regions of Kumaon, Himachal Pradesh, Punjab and Kashmir. The fruit is of considerable commercial importance in Ramgarh, Bhowali, Muktashwar, Ranikhet, Joshimath and Chulikote in Chamoli District. Kulu and Kashmir Valleys are also famous for apricot production in India.

ALMOND

The most important crop in Kashmir is almond, the output being one-third to one-half of India's supply. The raising of almond in this State is favoured by geographical factors. In general, the topography and climate of this State are suited to almond production but farmers

have to adopt their cultural practices to counteract the effects of relatively high humidity and the deficiency of sunshine. Although almonds are the main fruit of Kashmir it would be a mistake to think that the farmers raise this crop to the exclusion of all others. A few fruit growers received practically all their revenue from apples but the typical farmer got approximately 40% of his income from almond, the remainder coming chiefly from others. The almond growers usually also raised some plums, Cherries, Mulberry, Pomegranate *etc.*

STRAWBERRY

Sandy loam soils are the most desirable type for growing strawberries, but other types are suitable provided they are well drained but retentive of moisture and fairly fertile. Among the environemtal factors affecting strawberry production, water supply is most important, for the great bulk of strawberry is grown under irrigation, the strawberry fields being submerged under approximately 10 cms. of fresh, slowly moving water for at least three months. Strawberry requires a mean temperature of more than 16° C. during the growing season of two months.

Jeolikote in Nainital district is the largest producer of strawberries, producing nearly all the canned strawberries.

WALNUT

Walnut at present is extensively cultivated in the districts of Nainital, Almora, Garhwal, Chamoli, Tehri Garhwal, Pithoragarh, Himachal Pradesh, Punjab and some districts of Jammu and Kashmir.

MANGO

The mango or locally called Aam is common everywhere. The mango is largely cultivated in groves especially near towns or villages.

The deep alluvial soils of the Indo-Gangtic plain seem to be well suited for the growth of mangoes. In areas of heavy rainfall such as the Himalayan slopes, mango trees may be grown without irrigation but where rainfall is less than 105 cms a year, young trees are generally irrigated. It grows from sea level to 1524 m. above sea level in the Himalayan slopes. Freedom from rain and cloudiness, and from frost during the flowering season is particularly important. For its best development mango requires moderate cool weather during the early part of its flowering season and high temperatures during the ripening period.

Following are the main varieties of mango grown in India: Dashari, Langada, Chosha, Sapheda, Shahpasand, Fajli, Malda and Mohanbhog.

The main areas for mango cultivation in Andhra Pradesh and Madras are Coimbatore, Trichurapally, Arcot, Kurnool, Guntur, Mahbubnagar, Visakhapatnam, Krishna etc. The important varieties are Rajuman, Chonrasm, Kohlapalli, Kabari etc. Langada, Chosha and Dashari are famous in Madhya Pradesh, Nilm, Beganpalli, Dhuphal Salaza in Orissa, Mysore and Madras and Hapus, Bombya Pari, Rajapuri and Kasar *etc.*, are famous in Maharashtra and Gujarat.

THE BANANA

Bananas can be grown in some regions of temperate zone of India but the major production areas occur in sub-tropical and tropical climates with considerable rainfall. The average temperature required throughout the life period of the plant ranges from 20° to 30° C. In the southern and the peninsular India, the mean temperatures throughout the year are favourable for banana cultivation and many crops of banana are obtained during a year. In northern and western India, where the winter temperature is low, only one or two crops of banana during the months of March-October are possible. Irrigation is practised in certain localities, the water requirement of the banana plant is enormous, however, and consequently irrigation is feasible only where an abundant supply is available.

Banana growing is spread allover India. The areas of cultivation of banana in the South are Kerala, Madras, Mysore, Maharashtra and Andhra Pradesh, about 1000 m. above sea level. Besides these, Amarawati and Akola districts of Madhya Pradesh have also a thousand hectares of banana under cultivation.

In Bihar the most important districts producing bananas are Champaran, Saran, Darbhanga, Bhagalpur, and Purnea etc.

In Bengal banana is extensively cultivated in the districts of Malda, Murshidabad, Burdwan, 24 Paraganas and Nadia.

At present, banana is extensively cultivated in Assam in the districts of Cachar, Kamrup, Sibsagar, Lakhimpur, Garo Hills and United Khasi and Jaintia Hills. The coastal districts of Orissa are also famous for its growth.

The banana gardens of U. P. are located on the hills and slopes of Siwalik. The Himalayan slopes, north of Siwalik is an important banana area. The physical condition of the soil does not seem to be very important, provided it is deep and well drained. In sub-tropical region of Kumaon and temperate region of Uttarakhand, plantations are generally made on virgin forest soil, with its accumulation of humus, and under such conditions bananas can be grown for many years without manuring. Bananas, mostly of an inferior type, are grown in the river valleys of Kumaon and Uttarakhand Divisions of U.P. up to an elevation of about 1000 metres. In hills cold winters, causing damage to some plants, and hot winds in the summer which shred and

dry out the leaves. The occurrence of frost proves to be very harmful for the local vegetables and plants. Some times it also affects banana trees adversely.

Within Indian Republic, Kerala stands out predominantly in acreage followed by Mysore, Maharashtra, Orissa, Andhra Pradesh, Assam, Madhya Pradesh and Uttar Pradesh.

THE CITRUS FRUITS

The citrus fruits, including the orange, the lemon, the grapefruit and several others are of small commercial importance.

ORANGE

The orange is the most important citrus fruit grown in India and is widely distributed in south and north India.

The correct selection of the proper soil for orange trees is perhaps of more importance than that entailed in the selection of soil for any other crops. This is true because an orange orchard represents a long time and costly investment, and the plants occupy the same area for many years. The discovery that the soil is unsuited for orange trees often occurs only after the orchard has been growing for a number of years. This results in great economic loss, because to improve the soil is impossible or highly expensive and to retain the orchard means only poor to moderate yields.

In Bengal where the precipitation is fairly enough and evenly distributed over the year, a soil 2 metres deep is satisfactory for orange. In Madhya Pradesh, where orange orchards are planted on red-brown soils and where protected summer droughts occur, a depth of 7 metres is being recommended. In Gangetic plain, orange trees live longer and produce more fruits on well-drained, even textured, sandy loam soils which permit root penetration to a depth of 3 to 4 metres than on more heavily textured soils in which the tree roots penetrate only about one metre.

Orange is grown in almost all the States of India, but its cultivation is mostly concentrated in U.P. (Kumaon, Dehra Dun, Uttarakhand, Saharanpur, Tehri, Punjab (Kangra) W. Bengal (Darjeeling), Mysore (Coorg), Andhra Pradesh (Hydrabad, Orangabad), Maharashtra (Nagpur and Poona) and Jammu and Kashmir. Orange in Assam is mainly grown in Khasi Hills, Garo Hills and many other places.

There are four well known varieties of orange :—

(1) *Citron.* To this belongs the wild varieties known as *bijaura* and *Karanphal* found in Assam and Hill regions of U.P., Himachal Pradesh.

(2) *Lemon (Limonum).* Madden refers to this variety as being found wild in Kumaon and other Hill areas of northern India.

(3) *Sour Lime.* This includes the *nibu* and its cultivated varieties, the *Kaghazi etc.* They are much employed for *Sherbets* and the like and thrive well in the warm climate.

(4) *Sweet Lime or Limetta.* This variety is cultivated in suitable localities in Hills of Assam, U.P. and Himachal Pradesh.

GRAPES

Grapes are grown in nearly every place of the temperate and tropical climates. It must have a long summer, a moderately fertile well drained soil, a relatively low water supply during the growing months even less with relatively high temperature, a bright sunshine during the three months in which the fruit matures. In Kashmir a mean temperature of about 15°C. in the month of June is one of the reasons for production of high quality grape.

Grapes are grown all over India, but there are certain areas where the fruit is grown more intensively than in others. Among these areas of intensive cultivation are Assam, Kumaon, Himalayas, Kashmir, Maharashtra, Mysore and Madras.

GUAVA

Guava is a winter season crop. Good fruits are produced on a wide range of soils but sandy loam soils are usually selected for early crops, heavy soils for late market and canning crops. Guavas for the best development require somewhat warm weather during the early part of the growing season and moderately low temperature during the latter part.

Although Guavas are produced in several rather concentrated parts of Allahabad, Faizabad and Gonda, they are grown largely in Nainital, Bijnore, Bareilly in U.P., Sangli and Satara and Nasik in Maharashtra, Mehsana in Gujarat. Guavas are also grown in Bihar, Madhya Pradesh and Andhra Pradesh.

Figs, Lichi, Loquat, Water-melon, Water-chestnut, pine-apple, Pistachio, Wild fig *etc.*, are also important.

Export of Fruits

For the year 1963-64 India exported a sizable amount of Fruits to various countries of the World and earned foreign exchange. The following table LXXXIII shows the export of fruits from India in 1961-62 to 1963-64.

TABLE LXXXII : *Export of Fruits*

Fruits	1961-62 Quantity in metric tons	1961-62 Value in Rs. mln.	1962-63 Quantity in Rs. in tons.	1962-63 Value in Rs. mln.	1963-64 Quantity in m. tons	1963-64 Value in Rs. mln.
Apples	3	0.012	9	0.025	2	0.007
Bananas	7082	1.976	11,269	3.181	9225	3.064
Citrus [1]	3913	1.463	3,559	1.188	1286	0.387
Grapes	3	0.01	4	0.009	2	0.006
Mangoes	2109	1.912	1803	1.521	1548	1.562
Pine apple	73	0.051	251	0.008	—	—

VEGETABLES

Besides the fruits mentioned above, a large number of miscellaneous vegetables are cultivated in India. With the growth of the urban population and the health propaganda for eating more fruits and vegetables the cultivation of horticultural crops has considerably increased within recent years.

Vegetable growing is mainly practised in the vicinity of town and cities. Being of short duration, two or three crops of vegetables can be raised on the same piece of land and they prove to be a remunerative source of income to the grower.

The important vegetables are Cauliflower, Cabbage, Cucumber, Carrot, Brinjal, Coloquintida, Pumpkin, Gourd, Tomato, Sweet potato and Potato *etc.* Potato is the most important vegetable in India.

Potato. Potato is grown as a pure crop, and in general two crops, an early and late one, are grown. The early crop is sown about February to March and harvested about June-July. The late crop is sown about September and harvested about December to January.

The crop is grown under diverse conditions in the country from almost plain to elevations of 2000 metres. The potato tolerates a variety of soils. The soils most suited to the cultivation of the potatoes are heavy soils, clays, grey and red soils. The most important groups of soil under which the crop is grown in the country are the loam, sandy clays, grey and red soils. The potato crop needs a hot and humid climate.

---

1. Citrus fruits include orange, Lemon Lime and others.

During the three years 1960-63, 5532, 5448 and 5144 metric tons of walnuts costing Rs. 17.483 million, Rs. 15.034 million and Rs. 12.832 mln. respectively were exported. It is now proposed to set apart 400 heactares in Himachal Pradesh for growing walnuts of exportable variety.

The growing of potato is confined mainly to Northern Bihar and Uttar Pradesh, which together contribute about two thirds of the country's potato production. Potato growing is mainly done in Punjab, Assam, Himachal Pradesh, Maharashtra, Madras and Madhya Pradesh. Other important potato growing states are Mysore, Orissa, Gujarat, Tripura and Rajasthan.

Within Indian Republic, Uttar Pradesh occupies the largest area, 32 percent, Bihar occupies 16 percent, West Bengal 12%, and Punjab, Maharashtra and Madhya Pradesh come next with 4 percent. Himachal Pradesh, Orissa and Madras, though important potato growing areas, occupy only 3 percent each of the total Indian acreage. The remaining acreage is scattered in the other states of the union. The following table LXXXIII shows the statewise production, acreage and yield per hectare.

TABLE LXXXIII : *Acreage, Production and Yield of Potatoes*

State	Acreage (thousand hectares)	Production (thousand m. tons)	Yield per hectare in Kgs.
Andhra Pradesh	.4	2	800
Assam	30.0	120	660
Bihar	62.0	281	740
Maharashtra	12.0	74	1500
Gujarat	2.0	15	1600
Madhya Pradesh	9.6	50	820
Madras	9.2	71	1240
Mysore	5.6	17	380
Orissa	8.4	28	390
Punjab	10.0	141	2260
Rajasthan	1.2	4	390
U. P.	103.2	711	1100
W. Bengal	49.2	389	1280
Himachal Pradesh	8.8	27	404
Tripura	1.2	4	390

Production of Potato in 1950-51 was reported to be 1,660,000 tons. India, which had the highest acreage, accounted for below 1 percent of the world production. The average acreage under potato in the same year was 240 thousand hectares. The highest acreage was recorded in 1960-61 when it reached a peak of 375 thousand hectares. The year 1964-65 saw a further increase in acreage reaching a new height of 417 thousand hectares. The trend of acreage since 1950 to 1965 is given in table LXXXIV.

TABLE LXXXIV : *Area under Potato*

Year	Acreage (thousand hectares)
1950-51	240
1955-56	280
1960-61	375
1964-65	417

India has fairly increased her potato production in recent years, which is evident from the following table LXXXV.

TABLE LXXXV : *Production of Potato*

Year	Production (in 000 tons)
1950-51	1660
1955-56	1859
1960-61	2719
1965-66	3452

The per capita consumption of potato in different regions of India displays wide variety, depending upon the food habits and consumer preferences of each tract. Consumption of potato also varies in urban and rural areas of the same State. For instance, it is much lower in rural areas than in urban parts of the country. Similarly, in Madras, Calcutta or any other urban centre, potato constitutes a more important part of diet than rural. In many parts of the country, 80 percent of the production is consumed in various cooked preparations.

SPICES

The important spices are cloves, cardamom, turmeric, black pepper, chillies, coriander seed, cinnamon *etc.* Spices have acquired a position of great importance in the economy of the plains on the south-west coast of India.

The area under black pepper, an important dollar earner which yielded Rs. 25 crores from exports of 20 thousand tons during 1964 as against an annual decade average of Rs. 3 lakhs, still stands at 103 thousand hectares and has recorded only a nominal increase. Official estimates of the areas under cardamom and lemon grass are not available. trade estimates place the average areas in the neighbourhood of ·4 hectares and 10 thousand hectares respectively. Cardamom yields Rs. 1.46 crores of foreign exchange. Cashew nuts, which bring another Rs. 8 to 9 crores of foreign exchange through exports, are largely imported, processed and then exported, the value of the imports being of the order of about Rs. 2.8 crores. In spite of phenomenal increases in prices little change in area under cashewnuts and spices appears to have occurred. The following table LXXXVI shows the area under spices and cashewnuts.

TABLE LXXXVI : *Area under spices and cashewnuts (thousand hectares)*

States	Turmeric	Pepper	Ginger	Chillies	Cashew-nuts
Andhra Pradesh	15.6	—	6.8	170.8	—
Assam	—	—	—	3.2	17.2
Bengal	1.2	—	5.6	5.2	—
Bihar	7.6	—	—	40.8	—
Gujarat	.4	—	3.6	7.6	—
J. & K.	4.4	—	—	—	—
Kerala	.4	898.8	91.6	3.2	48.4
Madhya Pradesh	5.6	—	14.0	42.0	—
Madras	—	2.4	4.8	62.4	.4
Orissa	.8	—	6.0	6.4	—
Punjab	7.2	—	2.8	26.4	—
U. P.	1.2	—	—	3.2	—
Andaman & Nicobar	.4	—	—	—	—
Delhi	1.2	—	—	.4	—
Himachal Pradesh	—	—	11.2	.4	—
Tripura	.4	—	—	.8	—
Rajasthan	.4	—	.8	22.8	—
Maharashtra	—	—	2.4	128.4	2.0
Mysore	.8	22.0	4.0	106.4	28.4

Black Pepper is a tropical crop, and, therefore, the summer season of four to six months suits it well, but the crop requires intermittent rains for its early maturity. The areas of good pepper in Southern India get good quantity of rainfall from 150 to 200 cms. Black pepper grows well in loam and sandy loam. Kerala, Madras and Mysore provide very ideal climatic conditions for the growth of black pepper.

The following table LXXXVII shows the production of black pepper in India since 1948 to 1965.

TABLE LXXXVII : *Acreage and Production of black pepper*

Year	Acreage (in 000 hectares)	Production (in 000 metric tons)
1948-49	77.3	20
1949-50	78.4	21
1950-51	78.5	21

1951-52	80.8	23
1952-53	80.8	23
1953-54	83.2	24
1954-55	84.8	26
1955-56	88.0	28
1956-57	88.4	27
1957-58	99.6	26
1958-59	92.0	25.5
1959-60	92.8	25.4
1960-61	103[1]	28
1964-65	103[1]	24

Trade of black pepper. Over 15,000 metric tons of black pepper, about 60% of the total production was exported during the year 1953. Main importers were U.S.A., Canada, Mexico, Cuba, Central America, U.K., U.S.S.R., Italy and Aden *etc.*

Chillies. Chillies are grown in almost all the States of India. The Chilli crop requires high temperature and high humidity, with abundance of water during its life period. Chillies grow well in loamy and sandy alluvium soils. The crop is sown about July to August and harvested about October to March.

Within the Indian Republic, Maharashtra occupies the largest area (115000 hectares), Mysore occupies (98000 hectares), Madras, Bihar, M. P., Punjab and Rajasthan come next with 55,000 40,000, 38,000, 26,000 and 22,000 hectares respectively. Andhra Pradesh is the largest Chilli producing state in the Indian Republic. Other important areas are Gujarat, Uttar Pradesh, West Bengal, Himachal Pradesh *etc.*

The following table LXXXVIII shows the production of chillies in Indian Union.

TABLE LXXXVIII : *Acreage and Production of Chillies in India*

Year	Acreage (thousand hectares)	Production (lakh metric tons)
1948-49	484	3.0
1949-50	508	2.9
1950-51	584	3.5
1951-52	556	3.4
1952-53	496	2.8
1953-54	536	3.0

1. Thousand hectares

1954-55	632	3.8
1955-56	636	3.5
1956-57	592	3.4
1957-58	612	3.5
1958-59	592	3.3
1960-61	667	419[1]
1964-65	714	455[1]

The use of Chilli is totally confined to local consumption and its importance from the point of view of commerce is almost negligible.

Ginger. Ginger is a tropical crop. Ginger grows well in areas where the temperature varies from 10 to 15 °C. Ginger grows well in alluvium and light clay soils.

India occupies a unique position among the Ginger-producing countries as it with deals nearly 80% of the World production. The crop is grown in almost all parts of the country. But its cultivation is concentrated mostly in West Bengal, Orissa, Madhya Pradesh, Andhra Pradesh, Madras, Mysore, Himachal Pradesh and Punjab, which together account for about 90 percent of the country's production.

Table LXXXIX shows the production of Ginger since 1948 to 1965.

TABLE LXXXIX : *Acreage and Production of Ginger*

Year	Acreage (thousand hectares)	Production (thousand metric tons)
1948-49	21.2	22
1949-50	22.4	23
1950-51	16.0	14
1951-52	17.4	14
1952-53	18.4	19
1953-54	19.2	14
1954-55	14.8	14
1955-56	16.0	16
1956-57	15.6	15
1957-58	15.6	14
1958-59	14.3	12.3
1959-60	14.8	13.8
1960-61	19	18[1]
1964-65	22	21[1]

[1]000 tons.

Other important spices are turmeric, cinnamon, coriander-seed, etc. The use of spices is totally confined to local consumption and its importance from the point of view of commerce is almost nil.

QUESTIONS

1. Write an essay on Horticulture in India. Emphasize citrous and deciduous fruits of great commercial value and the industries based on them.
2. Discuss the production and trade of citrus fruits in India, giving details of the geographical and economical conditions influencing the industry.

CHAPTER 16

Agricultural Regions of India

A complete classification of major agricultural regions of India not only shows the distribution of crops, animals, rainfall, soil and other data, but it also explains the relationship between these factors in such a way that it is possible to trace major influences which have shaped the pattern of agriculture and which will indicate the path of future agricultural development. As previously stated, climate will generally be found to be the principal basic factor which accounts for regional differences in agriculture.

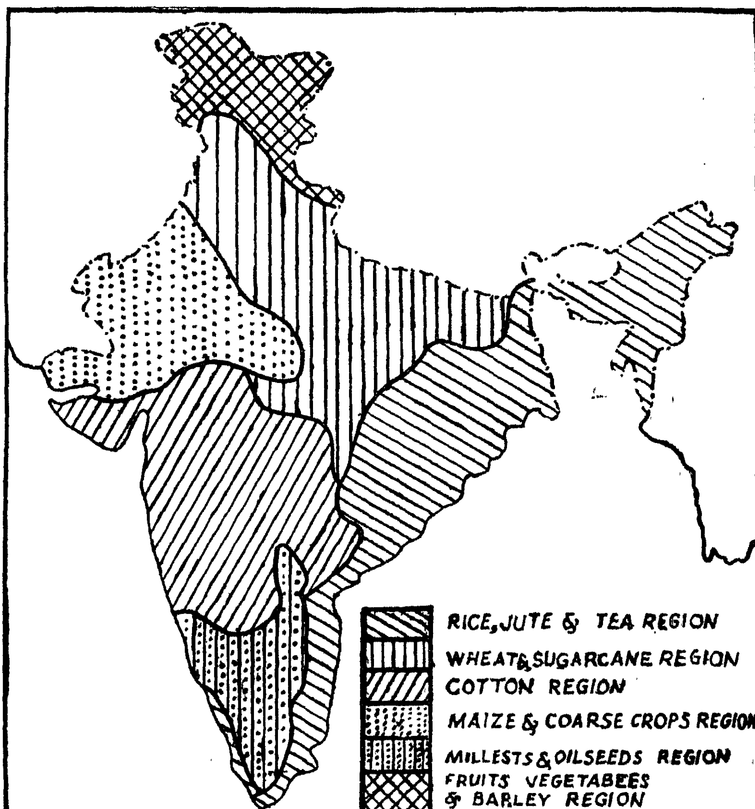


Fig. 37. Agricul ral Regions of India.

Map 37 shows the agricultural regions of India, greatly simplified. In order to present a more complete picture, the individual zones will be discussed. The map shows quite well the general sequence from South to North. Different crops are predominant in different agricultural regions of India. Rice and Jute are raised mainly in South-Eastern states of India, wheat and sugarcane in the middle zone. Cotton in black soil region and fruits and vegetables in temperate regions of India. Diversity of products in India is the outstanding characteristic of agriculture. The use of land, like the climate, is marked by transition. It changes from the rice, Jute and wheat of eastern region, still prevailing in the middle, to the wheat and sugarcane economy of Uttar Pradesh and Punjab. According to such statements it might be concluded that no general principles of agricultural classification can be propounded, and that every land use plan requires an *adhoc* classification. However, the main agricultural regions of India are—

1. Rice, Jute and Tea Region.
2. Wheat and Sugarcane Region.
3. Cotton Region.
4. Coarse crops and Maize Region.
5. Fruits and Vegetables Region.
6. Millets and Oilseeds Region.

1. *Rice, Jute and tea region.* This area, which comprises Assam, West Bengal, Orissa and certain parts of Bihar, grows rice in the basins of Brahmaputra, Ganga and Mahanadi rivers and has the highest intensity of rice cultivation in the country.

This region is characterised by an abundance of moisture. Over most of the area the rainfall varies between 182 and 254 cms. during the year; the larger proportion of it coming during the summer months of June to October. Uniformly warm temperatures are another climatic characteristic of this region.

The region is occupied by the lowest ends of several rivers and naturally, therefore, comprises of low ground. River banks and depressions are the two most important physical features of the area.

Composed mostly of the alluvial soils brought down by the rivers, this region has a high agricultural value, except in the lower delta of the Ganga and in some parts of the Burdwan district. The proportion of the area under crops to the total area is very high.

The most dominant character of agriculture in this region is that there are only a few crops grown over large areas. The number of crops grown is not large. Rice, jute and tea are the outstanding crops. Oil-

seeds, sugarcane and cotton are other important crops of this region. The climatic conditions, as well as the large population to be fed, naturally make rice the most widespread crop of the region. Rice dominates the landscape as also the outlook of the people. This need for growing rice in this region wherever possible, leaves very little land for commercial crops.

Irrigation plays the least part in the agricultural operations of this region. Irrigation canals or wells for irrigation are almost unknown in this region. Whenever thare are long breaks in the monsoon rains, some irrigation by lifting water from the numerous depressions, which have almost always some water, is practised.

As manuring is not common in rice cultivation, and as rice is the most widespread crop, the use of manures (except in tea plantations) is not important in this region. The annual floods, in fact, supply such large quantities of new, fertile silt every year to the fields that the soil naturally recoups its fertility without any manure. In tea plantations, however, the use of manures is common.

Owing to the large agricultural population in relation to the area fit for cultivation, the fields are generally very small in the region. These fields are cultivated with the help of bullocks, the use of agricultural machinery being almost unknown here. Most agricultural operations are done by hand labour, which is a characteristic feature of all rice lands. The stagnant water in the depressions and in the rice-fields breeds malaria which saps the health of the agricultural labourers and agricultural labour is, therefore, not very efficient here. During the last war to protect the soldier much was done to eradicate malaria by providing drainage canals and spraying of insecticides.

Weeds are very common in the fields here. A very serious problem facing agriculture in some parts of this region, specially Bengal, is the spread of the **Water Hyacinth.** This weed takes root in the stagnant water and is difficult to eradicate. It completely chokes any crop growing in such water, and thus makes large areas, formerly good agricultural land, unfit for crop cultivation. The Government is spending a good deal of money in research work to free the land from this curse. The reeds are also a menace to cropland.

The lack of good fodder supply is the cause of the dearth of good and healthy animals in this region. Rice, which is the most widespread crop here, does not yield a suitable or nourishing fodder for animals. The other important crops grown here do not yield any fodder at all.

Besides, the climate and soil here do not favour grasslands. The depressions are almost always covered with water, and so grass cannot grow there. The uplands or river banks are valuable farming land and

cannot be left over for grass. The areas unfit for agriculture are also unfit for grass. For example, the lower delta is subjected to saline tide water which does not permit the growth of suitable grass for fodder. The crystalline soils belonging to the peninsular class are too porous for the growth of grass.

Dairying or meat production are, therefore, not important in the agriculture of the region.

2. *Wheat and Sugarcane Region.* The area comprising Northern Bihar, Uttar Pradesh, Punjab and Certain parts of Madhya Pradesh, has its main wheat season from october to April.

Oridinarily, the rainfall in this region is neither too much nor too little for agricultural purposes. The seasonal character of the rainfall distribution, however, makes irrigation an integral part of the agriculture of this region. There is a clearly marked rhythm in the winter and summer temperatures. The winters are cool, while the summers are hot. Based on these temperature differences, the crops grown in the region fall into two distinct classes. The rabi crops are suited to winter conditions, while the kharif crops are suited to summer conditions.

As seen above, irrigation plays an important part in the agriculture. This irrigation is, however, confined entirely to winter crops which are grown when the season is characteristically dry. Wells predominate in the irrigation of this area. Nowhere else in India are there better geographical conditions for well irrigation than in this region. The high water-table, the occurrence of claybeds in the sub-soil, the predominance of saturated sand, the filtering of water from the more rainy areas of the Himalayan foot hill—all these provide the most favourable geographical conditions for well irrigation.

Even though well irrigation is the most characteristic form of irrigation in this region, canal irrigation is not far behind. The most important canals of the region, the Ganga Canal, the Jamuna Canal, the Agra Canal and the Sarda Canal irrigate considerable areas of land.

An important feature of the agriculture of this region is the multiplicity of crops grown here. There is hardly any other part of India where the variety of crops grown is so great as it is in this part. This multiplicity of crops depends, of course, on the absence of extremes in agricultural conditions. There are moderately varying conditions of rain-fall, temperature and soils which enable a large number of crops with varying requirements to be grown in this region.

Considerable use of manures is another important feature of the agriculture of this region. The importance of wheat and sugarcane, which need considerable nutrition from the soil in order to yield well, makes the use of manures incumbent. The manure used consists largely of the animal refuse and domestic refuse. The large number of animals found in this region is, thus, a great help in providing animal manure. The fact that a large amount of cow-dung is used as a domestic fuel in a region where the demands on soil fertility are so great is a great agricultural drawback. Cow-dung is a valuable manure. Its use for any other purpose, therefore, deprives the soil of a source of fertility.

The most important crops of the region are wheat, rice and sugarcane. There are distinct areas in which these crops predominate; as for example, wheat dominates the western section, rice the eastern section and sugarcane the middle section of the region. These crops occupy generally the best land. The inferior soils are given over to the cultivation of pooer crops, like barley and millets, etc.

The occurrence of large areas of pastures, especially in the lowlands near the numerous rivers, enables a large number of cattle and other animals to be kept. Most of the cattle are meant for agricultural operations. Dairying is, however, being encouraged in the neighbourhood of large towns.

Due to the vagaries of rainfall, large parts of this region suffer now and then from famines. The 'famine zone' is marked particularly in the areas that adjoin the Peninsular region. The famines cause the greatest damage to the poorer food crops, and hence the greatest suffering to the poor. For the more valuable crops are generally grown in areas which are well supplied with irrigation facilities. Rice suffers most during famines, as it requires the greatest amount of moisture and is grown in areas where obviously, canal and well irrigation are least developed.

Fields in this region are very small. The agriculturists are generally very poor, due to the great pressure of population on land. The presence of the industrial town of Kanpur, and the towns manufacturing sugar, makes it possible for the agriculturists of this region to supplement their income from agriculture by working in these towns during the slack season when agricultural operations do not need them.

The presence of large towns has offered an incentive for growing fruits and vegetables in this region on a fairly large scale. Large quantities of potatoes and cauliflowers are grown in the area around big cities and urban areas. These vegetables find ready profitable markets even in distant places like Calcutta and Delhi.

3. *Maize and Coarse crops Region.* This area, which comprises western districts of Madhya Pradesh, Rajasthan and northern Gujarat, has its main coarse crops season from July to October.

The contrast between winter and summer temperatures is marked here more than in the wheat and sugarcane region. The winter crops, like wheat, therefore, flourish here better than in other parts of India. The winter rainfall in this region is enough for the growth of these crops.

The soils of this region are mostly alluvial silt which approach desert conditions wherever rainfall is deficient. The hot and comparatively dry climate of the areas causes considerable evaporation of water. In some cases this evaporation draws to the surface salts from the sub-soil. These salts lie as a crust over the soil and destroy its agricultural usefulness.

Maize, Bajra and other coarse crops are among the most important crops of the region. Canal irrigation is the most important feature in some regions in the plains.

The proximity of the Sind and Rajasthan desert, which is the chief breeding ground of the locust in India, makes this region specially liable to attack by locusts which may cause, therefore, very serious damage to crops in this region. Large sums of money are being spent every year by the Government to eradicate the locust-menace to this region.

The fields in this region are generally large and the cultivators here are better off than in any other part of India. The dry climate of the region makes them sturdy and so they labour on their fields harder than any other cultivators in India. The riches of the Punjabi cultivator are, therefore, the proper reward of his efficient and hard work on the fields.

The pastures in this region are poor due to dry climate. There is consequently a dearth of fodder for cattle and other animals in the region. The cultivators, however, have enough land and there is not much pressure of population on land. This enables them to devote some portion of their land, specially to growing fodder crops. The most important fodder crop grown in this region is lucern. There is no other part of India which has as great an acreage under lucern as this region. Fed on such a nutritive fodder as lucern, the cattle in this region are strong and healthy. Some of the Punjab breeds of cattle like the Hissar or Hariana breeds are famous all over India.

The coarse crops of India include certain parts of Rajasthan. The desert is not a wholly barren area where nothing would grow. On the contrary, wherever water is available for irrigation, agriculture is carried on. This agricultural land naturally occurs in river valley where well irrigation helps certain crops to grow.

Agricultural areas in the Desert Region occur in isolated localities. They are extensive. Whenever such areas occur, cattle population is found. The most important crops grown in this region are those that

require the least amount of moisture and yet can endure the great heat of the region during summer. Small millet (bajra) and moth is such a crop and is, therefore, grown extensively in this region wherever cultivation is possible. In favourable localities wheat is cultivated during winter.

In hilly areas in this region a few animals, especially goats, are reared on poor pastures.

The region provides the chief market for the surplus of agricultural produce in the neighbouring regions, as it does not produce enough itself. The cultivators in this region are poor though hardy. As its name implies, this region is the poorest of all agricultural regions of India.

4. *The Cotton Region.* This area, which comprises the black soil region of Maharashtra, certain parts of Madhya Pradesh and Gujarat, has the highest intensity of cotton cultivation in the country. The cotton region covers a large area in the peninsular India.

As the region extends over a large area, there are considerable local differences of climate and soil. Generally speaking, the region gets about 30 to 40 inches (75 cms. to 100 cms.) of rainfall. The temperatures are moderately high throughout the year.

Agriculture over large areas of this region is carried on by rainfall without much irrigation. The character of the rivers in this region is such that they cannot be used to any great extent for irrigation except in a few localities as in Gujarat. These rivers generally flow in gorge-like valleys far below the general level of the country. Lifting of water is, therefore, difficult for irrigating the fields. These rivers, unlike the rivers of the north, do not have their sources in mountain snows. Their water supply, therefore, is dependent entirely upon rainfall. They are mostly dry in the dry season. For well irrigation also the conditions are not generally favourable. It is only here and there that wells can be bored with any hope of getting water. These wells often dry up after giving water for some years. It is only in areas where the Black Cotton Soil is very deep that well irrigation becomes important. Thus, irrigation is not an important feature of this region.

The most important crop of this region is cotton. It is, however, not grown everywhere in this area. Only in those places where the soil is deep enough to supply enough nutrition it is retentive of moisture and specialise in cotton cultivation. Elsewhere, poor food crops like jowar and bajra (millets) are the important crops. Due, however, to local differences, a great many other crops are also grown in the region. Among these minor crops, mention must be made of wheat, the cul-

tivation of which is fairly important in the Malwa Plateau and in the valley of the Narbada. Sugarcane is another such crop which is grown in isolated favourable localities.

The Black Soil Region is varied by the occurrence of hilly areas here and there. The neighbourhoods of these hills generally provide extensive though poor pasture lands. On these pastures numerous cattle and goats are reared. Such pastures also occur in the neighbourhood of rivers whose banks are often a maze of ravines.

The fields are generally large in this region, but the soil is not equally fertile everywhere. Irrigation facilities are also not abundant. The yield from these fields is not, therefore, high. The cultivators are, therefore, generally poor in this region.

5. *Millets and Oilseeds Region.* The area comprising Madhya Pradesh, parts of former Hydrabad now in Andhra Pradesh, and Mysore, has its main millets season from June to November.

The region is covered by red and yellow soils, and in some places also by latrite, which are characteristic of areas composed of very old rocks. This part is geologically the oldest in India. The soils derived from these old rocks are generally infertile. This region, therefore, is markedly a region of poor soils. Continuous agricultural tracts as one comes across in the Gangetic Valley are, therefore, rare in this region. The topography of this region is broken or undulating. There are isolated blocks of hills belonging to the Satpuras and the Eastern Ghats. There are also the plateaus of Chhota Nagpur, Mysore and Andhra. This fact further reduces the area of agricultural land here. Valuable agricultural lands, however, occur in the depressions and in the river valleys wherever they widen out. In such areas there are deep deposits of finer soils which are well suited to the growing of valuable crops like sugarcane and rice. On elevations and slopes the soil is generally coarse and not very deep. In such areas only poorer crops can be grown.

The temperatures are high throughout the year and the differences between winter and summer temperatures is very little. The rainfall is copious, varying from 30 to 50 inches (75 cms. to 125 cms.) per year. Over most of the area rainfall comes both during summer and winter, but rain falls below the normal in this region more than anywhere else in India. This brings famine conditions which are so frequent here. The ravages of the famines are very serious particularly as the land is comparatively poor in fertility and the cultivators are not able to store large reserves of food. Even a slight departure from the normal rainfall causes distress, especially as the moisture requirements of crops in this region of high temperatures are great. These requirements can seldom be satisfied from other sources as the facilities of irrigation are not abundant. Famine must, therefore, be regarded as a chronic problem in this region.

Millets, particularly bajra, are the most widespread, because they are suited to the climatic conditions and the poor soils of this region as no other crop. Other important crops are groundnuts, cotton, rice and sugarcane. The absence of wheat cultivation to any extent, due to the poor soils and hot climate, is a marked feature. In especially favourable areas on the slopes of the mountain plantations are an important feature in this region. Tea, coffee, rubber and spices are produced in these plantations and tank irrigation is important.

The broken character of the land and infertile soils generally give rise to extensive pastures. These are, however, poor and can support only goats in large numbers. Cattle are not so important on these pastures as goats.

The fields are rather large, but the general infertility of the soils does not enable the cultivator here to get big yields from these fields. The cultivators in this region are generally poor. They are not very healthy and strong as the climate of the region causes various maladies. Hook-worm disease is widespread in this region. This disease gradually saps the vitality of the people and makes them weak.

It also includes the coastal plains lying on the western coasts of India. These plains are usually hot and moist. The soil is fertile throughout except in the neighbourhood of the sea where sand lowers fertility. The fertility of the soil has been increased now by the provision of canal irrigation in larger deltas.

Rice is the most dominant crop though sugarcane, tobacco, and cotton are also grown wherever conditions favour.

The fields are generally small, but the rich soil enables the cultivators to raise large crops from their fields.

6. *Fruits, Vegetables and Barley Region.* This area comprising Jammu and Kashmir, Punjab, Himachal Pradesh and Hill districts of Uttar Pradesh, has low winter temperatures, and only a single crop of vegetables and fruits can be grown from June to October. Short and medium duration varieties of crops are usually grown, as the crop should mature before the onset of winter.

In the area near the Himalayas where the rainfall is adequate, the variety of crops grown is considerable. But the areas where canal irrigation is the chief source of agriculture, the crops grown are few in number. The cultivation of fruits on the Himalayan slopes is a characteristic feature of the agriculture of this region. The cool weather crops consist of potatoes, barley etc. The sowing of these crops starts

here at the time when wheat is harvested in other parts of India. The growing season is short *i.e.*, 4 to 5 months. At times when a slight temperature decrease occurs, snowfall is frequent which is generally followed by frost. The clouds frequently drag the ground in autumn and humidity reaches saturation point for considerable periods. Ugal (Fagophyrum esculentum) is said to have the merit of not being injured by mists which in the rains settle on tops of all hills. Recently the potato, which is a cash crop, has been introduced in the Hills, it has profoundly affected the agriculture of the tract.

As might be expected, this area in food crops is limited as a direct result of rugged and high elevation. Above this agricultural zone, most of the mountains in northern India are densely forested, whereas the high elevations carry meadow grasses that are used for summer grazing.

QUESTION

1. Suggest a division of India into Agricultural regions, paying particular attention, in the selection of criteria, to features of significance in Agricultural economy.

CHAPTER 17

Power Resources

Coal is the basic fuel required for almost all industries and its importance in the industrial development and economic advancement of the country needs no reiteration. Moreover, a large and rich variety of by-products are obtained from carbonisation of coal and these form the essential raw materials for a multitude of chemical industries.

Coal is the key to many chemical operations, as well as the major source of heat or power. Partial alternative may be found in oil and gas or in water power, but coal remains supreme. The importance of coal in the world of today can scarcely be overemphasized, for as one authority observes, "of all the resources which are basal to our existing civilization the possession and utilization of coal must be placed first".[1] Coal is the basis of our modern machine civilization, because of its suitability for raising stream, smelting ores, and providing heat. In short coal is the attracting magnet. Coal is the most important source of power for commercial energy as would be evident from the table XC given below.

TABLE XC : *Commercial Energy in the Energy System.*
(In thousand of tons coal equivalent)

Year	Internal Consumption (Excluding Electricity generated)	Electric Generated Steam Diesel and Hydro	Oil Excluding Non-combustible	Power Alcohol and Benzol	Total
1946	21,701	2,750	2,780	22.2	27,259
1949	25,060	3,000	3,500	25.5	31,585
1950	24,324	3,070	3,850	25.5	31,269
1951	25,380	3,510	4,670	31.6	34,592
1952	36,030	3,670	4,600	40.0	34,340
1953	27,065	4,020	4,850	43.8	35,979
1954	28,340	4,500	5,090	39.6	37,970
1960	49,800	8,030	9,040	66.0	66,940

1 Edward Charles Jeffrey, *Coal and Civilization*, p. 2.

COAL

History of Coal Mining in India

The earliest authentic reference to coal mining in India was in 1774 when one Mr. S. G. Heatly in partnership with Mr. John Summer, an employee of the Hon'ble John Company obtained permission from Warren Hastings, the then Governor-General to exploit Panchette and Birbhum mines. This venture ended in failure in 1814. One Mr. Jones a British expert, started mining operations at Ranigunge coal fields to be succeeded in this venture by Alexander and Co. As their pioneering efforts met with failure, the operations were taken over by that farsighted ancestor of Poet Tagore, well known as Prince Dwarka Nath Tagore. From him it eventually changed hands, and in 1845 was founded the premier colliery company known as the Bengal Coal Company as the nucleus.

In 1920 there was the Coalfields Committee. In 1925, the Indian Coal Committee, in 1937 the Coal Mining Committee, in 1946 the Indian Coalfields Committee, in 1950 the Committee on the conservation of Metallurgical Co. It was in 1951 that the industry came to be blessed with the activities of the working party for the Coal industry and later on by the Report on the Planning Commission. No other industry seems to have invited so much of officiousness from the ruling powers.

All these official and officious attentions notwithstanding it took World War II for positive action to be taken and such action came in the shape of control over the prices of the production and the distribution of coal.

During the first years of World War II the industry was recovering from the serious setback of the two previous decades and it was not until the war had reached the Indian Ocean t at a ı ormal condition arose. The increase in demand produced better price retrospectively speaking at Rs. 4-8 per ton of Bengal Coal in 1942, it was still at the 1927 level. The inevitable shortage was however accentuated by increasing transport difficulties, which produced near-famine conditions. At the same time, labour was finding more lucrative employment and labour shortage produced a marked fall in coal production. Every effort was, however, made by the Government and the employers to increase production and since the middle of 1944 it became necessary to exercise a rigid control over prices and to ensure that coal moved only in accordance with a strict programme to essential consumers.

Distribution of Coal fields in India

The coal deposits of India belong mainly to different periods, the earlier being the lower Gondwana era, perhaps about 250 million years ago, and the later being the lower or middle tertiary era barely 15 to 60 million years ago. The Gondwana coals are overwhelmingly more

important than the teritiary coals, both in quantity and quality. (See fig. 38).

The Gondwana coalfields are distributed along three line tracts, namely, the Damodar and Sone Valley in Bengal and Bihar, the Mahanadi Valley in Orissa and Madhya Pradesh and Godavari and Wardha Valleys in Andhra Pradesh and Madhya Pradesh. They are found in segments of the crust which have been let down along fractures into the more ancient rocks, to which really their preservation at the present day is due.

The distribution of coal fields in the Indian Republic has been given in the tabular form below—

A. GONDWANA COALFIELDS

Area	Fields
Rajmahal	Hura, Gilhuria, Chuparbhita, Pachwara and Brahmani.
Deogarh	Kundit Karala, Sahajuri and Jainti.
Hazaribagh	Giridih, Chope, Itkhori *etc.*
Damodar Valley	Raniganj, Ajai, Jharia, Chandrapura, Bokaro, Ramgarh, Sand North Karanpura.
Palamau	Auranga, Hutar and Daltonganj.
Sone Valley	Singrauli, Korar, Umaria, Johilla River Valley fields and Sohagpur.
Mahanadi Valley	Talchir, Ib or Rampur and Hinagir.
Chhattisgarh	Tatopani, Ramkola, Jhilimili, Sanhat, Kurasia, Jhagrakhand, Koreagarh, Bisrampur, Bansar, Lakhampur, Panchbhaini, Sendurgarh, Korba, Mand river Valley fields, Raigarh and S. Raigarh.
Satpura	Mohpani, Sonada, Dulhara, Pathakhera, Kenhan Valley, Pench Valley.
Wardha Valley	Bandar, Warora, Wum, Ghugus-Tehwasa, Chanda, Ballarpur, Wamanpalli *etc.*
Godavari Valley	Sasti, Rajpura, Antargaon, Tandur, Ganaparam, Kothagudam, Lingola, Bandala-Allapalli.

B. TERTIARY COALFIELDS

Eastern Himalaya	Makum, Namdung, Nazira and Namchik Valley.
Western India	Palana near Bikaner in Rajasthan.

A. Gondwana Coalfields

The coalfields constitute a series of small sedimentary basins separated from each other by patches of barren rocks. Each of these contains a number of seams which vary in extent as well as in thickness. Some of the seams may be only a few inches thick, while others may attain a thickness of nearly 30 metres as the Kargali seam in the Bokaro field. In many cases the seams consist of alternations of coal and sandstones or shales from which the coal has to be extracted.

There are two main coal-bearing groups of strata in the Gondwana Coalfields, known as the Barakar and Raniganj Coal Measures. The Coal seams in these two measures are slightly different in age, character and composition. The Raniganj measures are the younger of the two and are well represented by the majority of the seams in the Raniganj-Asansol area. They contain 33% to 38% moisture, 30% to 36% of volatiles and 50% to 60% fixed carbon. They are either non-caking or at best poorly caking. The Coal seams of the Barakur Strata contain 1% to 3% moisture, 20% to 30% volatiles and 55% to 65% fixed Carbon. These are well-developed in the Jharia Coalfield where, in a total thickness of a little over 610 metres of strata, there is an aggregate thickness of 75 metres of coal.

The following table XCI shows the important Coal mines and the general characters of Coal.

TABLE XCI : *Important Coal mines and Analysis*

Mines and Seam	Moisture %	Volatile matter %	Fixed Carbon %	Ash %
Jharia Coal Field				
North Piprator	1.97	32.0	53.3	14.7
Hantodih	2.07	32.2	52.75	15.05
Bhatdih	1.7	31.0	54.5	14.5
Murlidih	2.2	29.30	57.0	13.7
Jamdoba (Seam 18)	1.70	28.10	56.80	15.10
Nundih (Seam 18)	1.80	28.8	59.3	11.9
Bhatguria (Seam 17)	2.0	28.13	58.85	13.0
Bhagband („ 17)	1.6	27.2	59.6	13.2
Bhagband („ 16)	1.3	24.5	60.2	15.3
Lodhana („ 14)	1.6	24.6	61.0	14.4
Dhariyazob („ 10)	1.00	19.00	62.4	13.6
Dhansar („ 8)	1.00	17.3	61.57	21.13

Raniganj Coal Field				
Ghusik	7.55	34.8	52.6	12.6
Naga	6.4	32.1	53.6	14.26
Dishergarh	2.57	33.95	54.95	11.1
Samela	11.00	31.5	57.1	11.4
Saturia	2.81	32.0	59.0	9.0
Poniyati	4.85	32.83	55.8	11.35
Barakar Coal Field				
Janch	1.63	28.96	56.02	13.39
Lamakdih	1.58	28.74	60.27	9.49
Bokaro Coal Field				
Kargali	1.16	23.57	58.26	16:31
Southern Coal Field				
Talchir	11.71	30.54	46.18	11.57
Panch Valley	7.48	31.24	44.28	17.04
Segareni	7.18	28.75	50.75	13.77

In general, it may be stated that all Gondwana coals are high in ash compared to the average coals of western Europe and Northern America. Moreover, the material constituting the ash, *i.e.*, clay, sand and other mineral matter is generally evenly distributed in the Coal substance and not as separate clots or bands, which makes it very difficult to separate it by ordinary methods of coal washing. This intimate mixture of ash and the coal substance is attributable to the fact that the coal was formed by accumulation of drifted vegetation in lagoons and marshes. No instance has come to light in India of the accumulation of vegetation in the place of which it grew, for geologists do not find any under-clays or stems of coalfield trees extending downwards as roots in the strata below.

Most of the Gondwana coals belong to the class called bituminous, covering a fairly large range of composition and used for various purposes—for steam raising, for gas production, and for general heating purposes. Bituminous coals are also divided into two groups, one which produces coke on heating to a fairly high temperature and quenching, and the other which does not possess the coking property. The coking quality of coal is of great importance for industrial purposes, particularly for iron and Steel-making where good coke is needed for metallurgical operations. There are as many as 80 individual coalfields in the Gondwana formations in India. The best known coalfields are those of Raniganj in Bengal; Jharia, Bokaro, Karanpura and Giridih in Orissa; the Pench Valley and Kanhan Valley the Umaria, Sohagpur

and other fields in Madhya Pradesh may be put on the border line or under semi-coking coals and may be useful for blending with strongly coking coals for the production of reasonably good metallurgical coke.

Practically 97 per cent of the coal supplies of India are derived from the Gondwana rocks which are found in the Deccan tableland. These rocks are very old and are composed chieflly of sandstones and shales which appear to have been entirely deposited in fresh water and probably by rivers. The only section of the Gondwana system which is important from the point of view of coal production is that known as the Damoda series from its development in the valley of the river Damodar. In rhe Raniganj and Jharia fields these rocks can be sub-

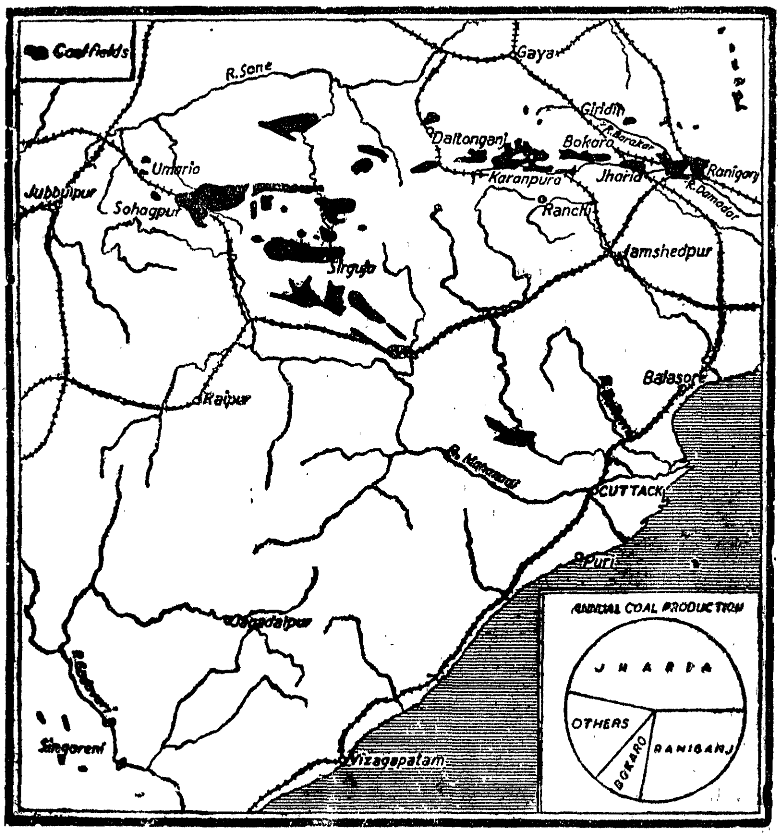


Fig. 38. The main coal-fields of India

divided into three stages or divisions, of which the top and bottom divisions, known respectively as 'Raniganj' and 'Barakar' rocks, alone contain coal seams. The rocks lying between these two divisions are 'ironstone' shales which possess no coal. The most important coal seams in the Raniganj coal-fields are found in the Raniganj 'rocks' while the most important seams in Jharia coal-fields occur in 'Barakar rocks'; that is, good coal occurs in upper rocks in Raniganj coal-fields, and in lower rocks in Jharia.

The fields which have been worked out to some extent in the Gondwana region include :—

(1) The Raniganj and Jharia fields in the Damodar Valley.

(2) the Giridih field occurring as a small isolated patch to the north of the Damodar Valley.

(3) the Daltonganj field, further west in the Palamau district.

(4) the Singareni, Ballarpur and Warora fields in Godavari Valley; and

(5) the Mohpani and Pench Valley fields adjoining the Satpuras.

The north-west ends of the Godavari and Mahanadi valley coal-fields have been buried under the great sheets of Deccan trap, and therefore, no one knows how much coal lies hidden under this cover. Similarly the eastern ends of the Jharia and Raniganj fields are buried under the Ganges alluvium making it impossible to determine the quantity of coal in India.

The Jharia coal-field is the most important Indian coal-field, not only because it produces about one-half of the total coal produced in india, but because it produces the best Indian coal. It is the only coal-field in India which has sufficient quantities of coaking coal. Its area is only about 150 sq. miles (387 sq. kms.). The 'Barakars', or the lower lays of the Gondwana rocks, are by far the most important of the coal mines. No attempts were made to work the thinner and poorer seam of the upper layers the Raniganj, until the boom in the coal prices in 1906-08 led to the opening up of every tolerable seam of coal within range of the railways. There are 18 seams in the lower Barakar, rocks totalling about 200 feet (61 metres) of coal, numbered from the outer fringe running like a crescent. The Raniganj mines are deepest in India and seams occur up to a depth of more than 2,000 ft. (610 metres). Except in the south-east corner of these seams, which is considerably faulted, there is little disturbance in the coal seams. By far the larger proportion of hard coke made in India is made from Jharia coal, and the recovery of coke averages about 75% of the coal used.

The coals of Raniganj, Jharia and Giridih coal-fields compare in quality as follows :—

Coal from the Best Seams

Coal-field Seam	Moisture %	Volatile matter %	Fixed carbon %	Ash %
Raniganj, Ghusik	7.5	34.8	52.6	12.6
Raniganj, Dishergarh	2.5	33.2	54.2	9.8
Jharia, No. 18	1.8	28.8	59.3	11.9
Jharia, Nos. 5-6	0.6	14.1	66.2	19.8
Giridih, Karharbari	0.9	22.5	66.0	10.6

A large quantity of the coal in Jharia field, as also in Raniganj and Bokaro field, has been burnt out by the Deccan lava. The damage caused is particularly great in the 14th and 15th seams. The evidence of this burning is to be found in the large quantity of '*Jhanwan*'.

The Raniganj field produces about one-third of the total coal of India. It covers an area of about 500 sq. miles (1290 sq. kms.) most of it being in the district of Burdwan, but stretching also across the boundaries into Bankura, Manbhum and the Santhal Parganas. It occupies a larger area than the Jharia coal-field. The seams dip generally to the south and south-east throughout the field. As dippings to the south-east are covered by the alluvium of the Damodar Valley, the distance to which the coal-bearing rocks extend in this direction towards Burdwan and Calcutta is unknown. There are six workable seams in the upper (Raniganj) rocks totalling roughly 50 feet (15.25 metres) of coal. The 'Dishergarh' seam of Raniganj has the most valuable steam coal in India which is in great demand for railways and ships.

The importance of the Jharia coal-field lies not only in the fact that it contains the best coal in India, but also in the fact that it lies on the margin to the Gangetic plain with a network of railways, and that it lies near Jamshedpur, Kulti, Asansol, and Calcutta which are the largest markets for coal in India. Jharia is connected by E. Rly. with Calcutta which is about 170 miles (270 kms.) from it. It is connected with Jamshedpur. The E. Rly. thus supplies its coal to the Indo-Gangetic plains and also carries it to the Indian peninsula. It covers an area of 175 sq. miles (450 sq. kilometres).

In spite of the good quality of coal in Jharia, no manufacturing industries of any importance have been attracted to it. The chief reason of this is the fact that there are no valuable raw materials near it. The immediate neighbourhood of Jharia consists of almost barren and rocky land where it is difficult to obtain large quantities of suitable water. Even the coal mining industry gets its water with difficulty. Unlike the best coal-fields of Europe or America, Jharia is, therefore unable to attract any industry to itself.

Immediately west of Jharia on the other side of the Jamui river lies the western termination of the Jharia field now known as Bokaro-Jharia. West of this again is the Bokaro field. Several of the Bokaro Coals have been proved to be capable of producing good quality blast furnace coke.

Ramgarh Coal Field. The small field known as the Ramgarh field lies from 24 to 32 kilometres south-west of Bokaro. It is traversed by the Damuda river in the bed of which the coal is found in numerous places.

Ballarpur Coal Field. Ballarpur was the first Colliery in India to adopt hydraulic stowage, which was introduced by Davies in 1913. The seams of Bollarpur are 16 metres thick. Two portions of it are workable. The upper portion is 7 metres from the bottom of the seam and is 3 metres thick; the lower is the bottom of the seam and is 3 metres; this leaves 5 metres between the workable portions, which, with the remaining upper 6 metres, are composed of shale and coal. The following analysis shows that the coal like most of the Gondwanas contains a large proportion of moisture, and also shows inclusions of pyrites.

Moisture	11.10	13.51
Volatile matter	31.56	30.61
Fixed Carbon	45.47	45.21
Ash	11.87	10.67

Mohpani Coal Field. The oldest colliery in Madhya Pradesh is Mohpani. The Mohpani Coalfield is situated in the Narsinghpur district on the south side of the Narmada alluvial valley, and at the foot of the northern spurs of the Satpuras.

Singareni Coal Field. The great belt of Gondwana rocks, near the north-west end of which Warora is situated, stretches down the Godavari Valley as far as Rajamundry, and at one or two places the equivalents of the coal bearing Damuda series in Bengal are found cropping up from below the upper Gondwana rocks. One of these occurrences near Yellandu in the Andhra Pradesh forms the coalfield well known by the name of Singareni.

Umaria Coal Field. The Bilaspur-Katni branch of the Bengal-Nagpur Railway passes through the small coalfield of Umaria in the former Rewa State now in Madhya Pradesh. The principal seam of coal is some 3 metres thick.

Korea Coal Field. The northern or Sonhat field contains two principal seams the lower of which is valueless in the western half of its course, but shows thickness of 1 to 3 metres over a length of 25 kilometres in the eastern part of the field. The upper seam is valueless in the east, but ranges from 1½ to nearly 3½ metres in the west. They

contain 6% to 9% moisture, 28 to 30% volatile matter and 44 to 51% fixed carbon.

Besides the above mentioned coal fields of great importance India has a few coal-fields of minor importance. The great belt of Gondwana rocks, near the north-west end of which Warora is situated, stretches down the Godawari Valley as far as Rajahmundry, and at one or two places the equivalents of the coal-bearing Damuda series of Bengal are found cropping up from below the upper Gondwana rocks. One of these occurrences, near Yellandu in Andhra forms the coal-field named Singareni. The principal seam of coal is about 2 m. thick which is a dull, hard and non-coking, steam coal largely consumed by railways and mills in Southern India.

In the foot hills of Bhutan coal has been found near the Kala Pani as highly inclined crushed lenticular seams near the junction of the enclosing Gondwana rocks with the Siwaliks, wh ch is marked by a reversed fault. The coal is of poor quality, friable, and does not seem to occur in any large quantity, the total length of outcrop at the principal locality being 275 metres, and the average total thickness not more than 4 metres.

TERTIARY COAL-FIELDS

The newer or Tertiary coals of Assam differ from the Gondwana coals in containing a large portion of moisture and volatile matter. They also generally have a lower ash content. The Tertiary coals have a high sulphur content which makes them useless for coking.

The tertiary coals of Assam are generally of quite good quality, except that they often contain 3% to 5% of sulphur which may occasionally go up to 7% or 8%. They have low ash, generally of the order of 4% to 7%, while the volatile matter is on an average around 45%.

As stated at the outset, there are also some useful coal seams in different horizons in the tertiary strata. These coals are found in upper Assam, as well as in the Garo, Khasi and Jaintia Hills on the Assam plateau. Some coal is found in the tertiaries of Kashmir. Seams of lignite occur in Bikaner and Jaisalmer in Rajasthan, the former being actually under exploitation. Another important lignite field was discovered in recent years in the South Arcot district of Madras where development is now taking place.

Coal of this age is found in Sind, Punjab, along the foot hills of the Himalaya and in the Andaman and Nicobar Islands.

The most important among the Tertiary coals are the Assam coals near Makum. The collieries are connected by a metre gauge railway with Dibrugarh on the Brahmaputra river, which being navigable forms both a market (used on steam boats) and a means of transport for coal. The coal-bearing rocks stretch over long distances both to the north-east and the south-west. The most valuable seams occur between the Tirap and the Namdang streams where, for a distance

of about five miles, the seams vary from 15 to 75 feet (4 to 23 metres) in thickness. Near Margherita, the average thickness of the thickest

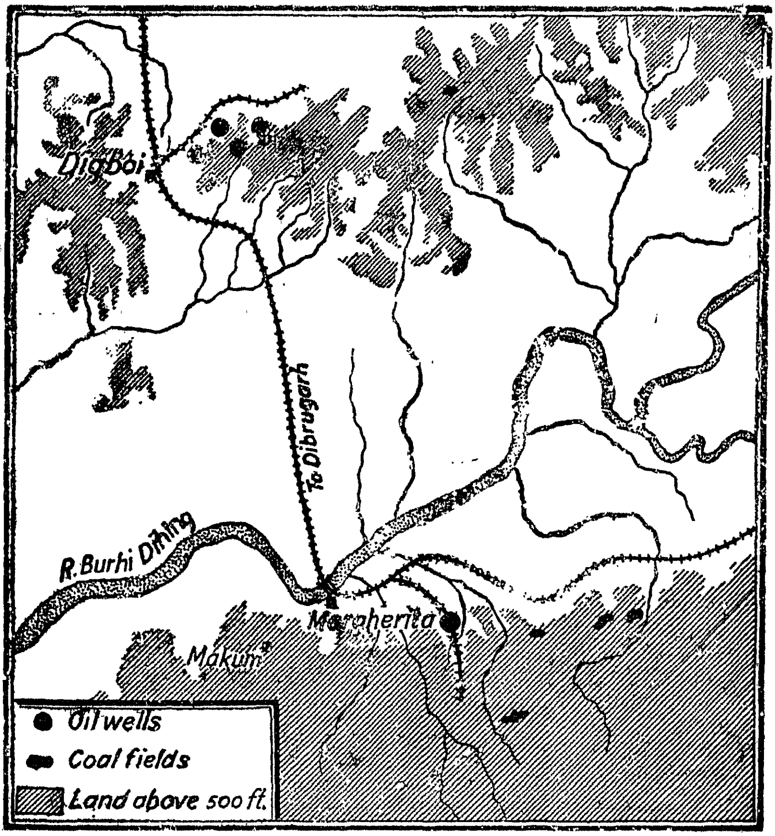


Fig. 39. Occurrence of coal and oil in Assam.

seam now being worked is about 50 feet (15.25 metres). In the Namdang section it increases to as much as 80 feet (24 metres). The outcrops in many places are several hundred feet above the plains on mountain slopes, and facilities exist for working the coal by adit levels as in Wales. Coal can be dug in horizonal tunnels, not in deep vertical pits.

Coal of good quality also occurs in the Namchick Valley, a tributary on the left bank of the Dihing River, above Margherita.

NEW COAL FIELDS

The Jaipur and Nazira Coalfields are to the south-west of the Makum field. The most important is the Nazira coalfield on the left bank of the Dikhu river. The coal seams of Nazira contains 5 to 7% of moisture, 34% to 42% volatile matter and 45 to 50% fixed carbon. The seam is 21 metres thick.

The Jaipur Coalfield covers an area of about 32 kilometres. It produces a good hard blast-furnace coke.

Coal occurs in various parts of Assam and has long been known to occur also in Mikir Hills. The chief outcrops are at Langloi, Disoma, Nambor and Doigroung. Of these Langloi seems to be the only area worth further attention; the coal there is very friable and greatly crushed, whilst the seam, which is about 3 metres thick, is much contorted; otherwise, its quality is good.

Coal is also found in the lower slopes of Kalais mountain in Garo Hills of Assam. The chief outcrops are at Walzong, Dhongring and Wamong. They form an isolated basin lying on the prevalent Plateau limestones, and consist of sand, shale and lignite coal, probably of Eocene age.

Further south east a coal-bearing belt of tertiary rocks has been found to extend throughout the length of the Khasi and Jaintia hills at least from the Garo Hills southwards. The high percentages of moisture and sulphur detract largely from the value of this coal.

Coal Fields of Rajasthan. Mining operations on the lignite of Palana in Bikaner were begun in 1898 at a point where the seam was found to be 6 metres thick. The coal is lignitic, containing large quantities of moisture, very low percentages of fixed carbon with very variable, often very high, quantities of ash.

At Shib 64 kilometres in a direct line to the north west of Jodhpur, there is a deposit of lignite similar apparently to others found in Rajasthan.

Kashmir. Coal has long been known to occur also in south western parts, but the prospects of successful exploitation are doubtful. The chief outcrops are at Kalkote, Matka, Mohogala, Chakar and Dadli in Chinab Valley, Landa, in the east of Chinab river and Ghansala and Sabalkote *etc.* The coal is of anthracite type, containing very high quantity of fixed carbon.

New coal-fields have been discovered in Rewa, M. P. (Pathakera and Koba) and Bihar (Hutar). The Garo hills in Assam, Jammu and (Kalakot) have been surveyed to contain large deposits of high grade coal. Large lignite deposits have been discovered in South Arcot districts (at Neyveli) covering an area of 16 sq. miles (41.28 sq. kms.) with 32 feet (9.7 metres) in thickness. This is said to be the longest find in India. The development programme for these deposits en-

visages the mining of 35 lakh tons per year of lignite which is to be used for (i) generation of power (2.5 lakh KW) (ii) production of carbonised briquettes (3.8 lakh tons); and (iii) production of fixed nitrogen (70,000 tons).

New coal deposits have also been discovered in the Daup area of Nepal Tarai (the western districts of Khajawali and Sohratgarh). Coal is said to be of high grade. Digging operations have been started with the help of the U.P. Government.

A reserve of 0.5 million tons of second and third grade coal in the Kota-Singrauli area in Mirzapur district, has been found by the Geological Survey of India, which has also recommended deep drilling for further proving of reserves.

In the above geological formations, quite close to Kota, extensive deposits of coal have been located by the Geological Survey of India at Navanagar (in Madhya Pradesh). Drilling is still going on.

In M.P. a new coal-field has been located in the Khobra area. The field is stated to cover about 200 sq. miles divided into two sections each containing about 6 million tons of first grade coal per square mile.

A coal-bearing region, extending over an area of 13 sq. miles (36 kms.) has been located in Bankura district of West Bengal. A new deposit has been located near Ondal, where Narsamuda and Upper Kajora bottom seams are inferior in quality but Upper Kajora top, lower Kajora, Bondahal and Topsikenda carry grade 1 coal. The reserve is estimated to be of the order of 5.26 million tons with a much larger quantity of probable reserves.

The discovery of lignite deposits in Kashmir has, it appears, opened up possibilities of industrial development for the State. The Kashmir Directorate of Industries has prepared a Rs. 7-crore scheme for the exploitation and utilisation of these lignite deposits discovered in the State. The scheme, to be completed in two stages, envisages, in the first phase, mining operations to produce 1,500 tons of lignite a day and installation of a thermal power plant and a capacity of 10,000 kilowatt. In the second stage, the plant will undertake manufacture of gas and fertilisers. Part of the gas will be used in the production of ammonia and the remainder will be supplied for fuel purposes to domestic consumers. The lignite deposits in the State, as discovered in 1923-24 were estimated at 128 million tons. In 1955-56 the Geological Survey of India surveyed Nichenama and Shaliganga *via* Barmulia and Sopore along a tract, 50 miles long and 10 miles wide (80 kms. to 16 kms.). The survey covered four sectors and the reserves were estimated to be about 86 million tons.

PRODUCTION

Today India stands eighth among the coal producers of the World. Her total production amounts to 496 lakh tons which was

about $1\frac{1}{8}$th of U.S.A.'s, $\frac{1}{7}$th of the U.S.S.R. and 5th of the British coal production for that year. This will be clear from the figures given below—

Coal Production (000 metric tons)

Country	1938	1958	1960	1962 (Million m. tons)
U.S.A.	357.9	389,355	478,055,000	396
U.S.S.R.	—	352,990	288,898,000	397
U.K.	30.6	219,287	249,739,000	201
Western Germany	151.3	133,582	143,886,000	8
Poland	—	949,81	101,885,000	—
France	46.5	577,21	59,926,000	54
Japan	—	496,74	49,066,000	55
India	28.7	460,66	42,146,000	61
China	—	—	95,356,000	—
Union of S. Africa	—	—	35,247,000	—

During the last three decades, coal production has nearly doubled and reached a record figure of over 56 million tons in 1960-61. Practically the whole of this 97 to 98% comes from the Gondwana Coal-field and 85 per cent is contributed by the coalfields of the Damodar Valley. The production of coal in India since 1939 has been as follows :

TABLE XCII : *Coal Production in India*

Year	Production in million tons)
1939	27.79
1940	29.38
1941	29.46
1942	29.43
1943	25.51
1944	26.12
1945	28.97
1946	29.27
1947	30.07
1948	29.82
1949	31.44
1950	32.31
1951	34.43
1952	N.A.

1953	36.55
1954	36.57
1955	38.39
1956	44.20
1957	44.20
1958	46.06
1959	47.82
1960	52.60
1961	56.71
1962	—
1963	—
1964	6,24,40*
1965	6,66,70*

The coal of Gondwana rocks is carbonized with an average carbon content of 70%, some of them running as high as 85%, while those of Northern Assam are chiefly supplied averaging 40% in carbon content. In 1960, India produced 52613.31 thousand tons of coal of which 25051 thousand tons were produced in Bihar, 16468 thousand tons in West Bengal and 6307 thousand tons in Madhya Pradesh. the following table XCIII shows the production of coal by States.

TABLE XCIII : *Statewise Production of Coal in India*, 1960.

State	Production (in thousand tons)
Bihar	25051.39
West Bengal	16468.15
Andhra Pradesh	2516·76
Madhya Pradesh	6307.24
Assam	633.05
Maharashtra	477.17
Orissa	776.08
Rajasthan	42.22
Total	52613.31

In 1960, the production of coal amounted to 52613 thousand million tons compared to 38,225,959 tons in 1956. The following table shows that Jharia has the highest production followed by Raniganj and Bokaro. The production of Coal in Assam is only 1% while Rajasthan has below 5%, Andhra Pradesh 4% and Pench Valley 5%.

*ooo tons, excluding lignite.

The following table shows the production of Coal in different coal-fields.

TABLE XCIV : *Fieldwise Production of Coal in India*

Name	Production 1956-57 (in tons)	1958-59 (0000 m. tons)	1960-61 (million tons)
Bihar			
Bokaro	2,415,311	2975.1	3.75
Giridih	224,057	434.9	0.46
Jayantia	8882	8.38	
Jharia	13,464,926	15182.6	16.09
Karanpura	1014,794	2093.9	4.48
Dalton	241,080	86.6	
Huttar	241,342	26.3	
Raniganj	12,974,907	1347.4	18.08
Rajmahal	6,597	5.08	0.88
Orissa			
Palamau	146,305	N.A.	
Rampura	292,961	N.A.	
Talchar	259,409	N.A.	
Bengal			
Darjeeling	23,284	29.7	0.04
Burdwan	N.A.	13660.3	
Bankura	N.A.	7.38	
Madhya Pradesh			
Pench Valley	1,996,874	23865	
Surguja	1,463,361	1808.3	
Raigarh	1578	6.6	
Rewa	N.A.	1213.3	
Korba	N.A.	64.6	
Maharashtra			
Ballarpur	226,573	N.A.	
Yeotmal	50,212	N.A.	
Nagpur	601	N.A.	
Satpura	10,60,450	N.A.	
Assam (all fields)	542,967	N.A.	
Rajasthan	28,944	N.A.	0.05

Production during 1965-66 was 496 lakh tons of which 398 lakh tons was produced in the private sector. Production in the year 1965 amounted to 665 lakh tons compared to 624 lakh tons in 1964.

COAL RESERVES

Systematic investigation of the coal fields of India was commenced during the latter part of the last century. Re surveys have been made at various times, the last general re-survey having been undertaken during the period 1924 to 1930. Sir Cyril Fox, under whose supervision this survey was conducted, estimated that the total quantity of Gondwana coal in India in seams of one foot thickness and over, and within a depth of 304 metres from the surface, was of the order of 60,000 million tons. If, however, the calculations were restricted to seams not less than $1\frac{1}{2}$ metres in thickness and containing no more than 25% ash on moisture-free basis, the reserves would amount to something like 20,000 million tons.

It is estimated that the total reserves of all kinds of coal in India amount to about 54,000 million tons. Of this only about 5 p.c. is supposed to be suitable for coking.[1] The three most important fields in respect of coal reserves are Raniganj (21,000 million tons), Jharia (20,000 tons) and north Karanpura (8,000 million tons). [2]

The Coal Mining Committee (1937) estimated the quantity of good quality coal at 4889 million tons, while Dr. Gee in 1944 placed this figure at 4,520 million tons. In 1946, Mr. A. B. Dutt estimated that there were 4,460 million tons of good quality Gondwana coal in seams not less than 4 feet thick and within 2,000 ft. (610 metres) from the surface. He estimated the resources of teritiary coal as 2,527 tons.

1. The 'coke' is made from coal by first powdering it and then burning it, untill the impurities in coal are removed, This burnt coal is then cooled by pouring water over it. Lumps then form. We, thus, have the coke. The capacity to form into lumps is the chief feature of 'coking coals'. Good quality coals produce 'hard coke' while the inferior quality coals produce 'soft coke'. The former alone can be used in the metal industries.

2. The National Planning Committee Report (Power and Steel), 1947 estimated the Reserves of India as follows:—

Total Coal Reserves of India

Darjeeling and Eastern Himalaya.	...	...	100
Giridih-Deoghar	...	...	250
Raniganj-Jharia	...	...	25,650
Sone Valley	...	...	10,000
Chhatisgarh and Mahanadi	...	...	5,000
Satpura Region	...	...	1,000
Wardha Valley	...	...	18,000
	Total	...	60,000

Of these reserves good quality coal is only 5,000 million tons of which Raniganj accounted for 1,800 million tons and Jharia 1,250 million tons.

Dr. Fermor of the Geological Survey of India estimated for the whole country the total quantity of coking coal suitable for the manufacture of metallurgical coke at the end of 1932 to be as follows :—

At depths of 0—1,000 feet (305 metres=)1,118 million tons. At depths of 1,000—2,000 feet (305 to 510 m.)=576 million tons.

Total—1,6056 million tons.

No doubt, in the opinion of Dr. Fermor, small additional quantities of good coking coal will be discovered in the future, possibly for example, in west Bokaro, but the probable amounts are not likely to alter the real position. In addition, with technical research coking coals, not at present regarded as coking coals, such as the semi-coking coals of Karanpura may also become available. But these are, after all, only possibilities.

Apart from Giridih, which is only a small field, the best coking coals in India occur in the Bhagaband and Jialgara stages of the Jharia field, 737 million tons of this is in depths up to 1,000 feet (305 metres) from surface and 163 million tons between 1,000 and 2,000 feet (305 to 610 metres). With the present methods of working not more than 50 p.c. of this coal will be won, and the remainder will be lost due to collapses, fires and floods. The total annual extraction from Jharia is about 10¼ million tons; practically all of which comes from the Bhagaband and Jialgara stages in which all the coking coal is concentrated. The life of the coking coal of the Jharia field, down to 1,000 feet (305 metres) from the surface is taken by Dr. Fermor to be 41 years under the present circumstances. He expects this life to be reduced to 33 years under normal development of mining in India. If the methods of mining are improved and sand packing is undertaken to check fires and subsidence, this life may be increased to 100 years.

Three big discoveries of metallurgical coal have been made at Bokaro and Raniganj, by the Geological Survey of India. These discoveries are expected to make India self-sufficient in grade one coal for decades to come. The quantitative and accurate qualitative estimates have yet to be made and the work has been handed over to the Indian Bureau of Mines.

The Metallurgical Coal Conservation Committee has estimated the reserves of coking coal at 329.6 million tons in respect of selected grade, 395.7 millon tons of grade I quality and 49.1 million tons of grade II quality. With stowing, washing and blending the Committee thought that a reserve of 2,000 million tons of good quality coking coal could be obtained. The Geological Survey of India estimated the reserves of Gondwana coal and Tertiary coal at 38,116 and 4,533 million tons respectively.

Reserves of Coking Coal

Considerable interest attaches to the reserves of coking coal available in India. This is because the country has enormous resources of

high-grade iron ore in Orissa, Bihar, Madhya Pradesh, Maharashtra, Mysore, *etc.* So far, the cheapest method of production of pig iron from iron ore is by the employment of the blast furnace process. It is possible to produce iron by the use of electrical energy instead of by heat derived from the burning of coal, but the cost of production will depend very largely on the price to be paid for electrical energy. Important technological developments like the use of high oxygen blast and utilization of atomic energy may change the picture completely. The smelting of iron ore in low shaft furnaces using non-coking coal is a possibility which is now receiving a great deal of attention in other countries. Any developments which help in the use of non-coking coal will greatly be welcomed by India as these will enable this country to establish smelting works away from the Bengal and Bihar coalfields containing coking coal. The estimates of coking coal have been estimated by the Metallurgical coal conservation committee as follows:—

	In Million Tons
(1) *Virgin Area*	
1. Selected A and B	329.6
2. Grade I	395.7
3. Grade II	49.1
(2) *Working Collieries*	
1. Selected A	404.0
2. Selected B	577.4
3. Grade I	512.9
4. Grade II	504.4

The trend in gradewise production of coal during the last few years discloses a tendency for an increasing proportion of total production to consist of grade I and inferior grades of Coal. The table below relating to the West Bengal and Bihar coalfields brings this out very clearly.

TABLE XCV : *Trends in Gradewise Production of Coal from Bengal and Bihar.*

(*million tons*)

Year	Selected A	B.	Grade I	Grade II	Grade III	Total
1951	7.203	9.404	5.080	4.501	2.028	28.216
1955	7.168	10.276	6.309	5.415	1.570	30.738
1956	6.826	10.396	6.988	5.296	1.842	31.348
1960	7.457	9.900	14.336	5.958	3.210	40.861

The total production increased from 28.2 million tons in 1951 to 40.86 million tons in 1960 but production of Selected A increased only from 7.2 to 7.5 million tons and selected B from 9.4 to 9.9 million tons. The production of Grade I rose from 5.1 million tons to 14.3

million tons, Grade II from 4.5 to 6 million tons and Grade III from 2.0 to 3.2 million tons. This tendency is attributable partly to the gradual exhaustion of the more easily workable reserves of Selected grades of Coal and the discontinuance of Selective mining and partly to the increasing mechanisation of minining operations.

The Working Party of the Coal Industry made an estimate in 1951 of the non-coking coal in the country and stated that the total quantity of non-coking coal, including tertiary coal was of the order of 39,650.25 million tons. The party, however, was not sure of the total reserves of good quality non-coking coal.

Coal Conservation

It is clear from the above that there is a great need for conservation of Indian coal. This need is to be doubly emphasised in view of the post-war and post-Independence schemes of industrial development in India. The best method of conserving Indian coal is to reserve the use of the best quality coals only for metallurgical industry. These coals should not be used for generating steam as in transport or industries. For steam purposes, for example, inferior coals from Raniganj or other coal-fields should alone be used. The most inferior coals should be used either in the form of liquid fuels or they should be used for generating electricity which can then be used for industrial purposes.

Conservation also implies a better system of mining. Miners should take out all coal that can be practicable. The present practice of taking out only the best quality coals and leaving the rest in the mines in such a way that it can never be recovered must be given up. It is obvious that this can be done only when it is realised that coal is a national asset on which the future of India depends, and that it is an asset which can never be reproduced. Once lost, it is lost for ever. This characteristic and the importance of coal make it necessary that the exploitation of Indian coal should not be left entirely in the hands of private capitalist.

Conservation of Indian coal also implies that every ounce of energy that can be obtained from it must be obtained, or every bit of by-product that it can yield must be recovered from it in the interest of the future of the country. The present wasteful method of softcoke making must, therefore, be changed. Dr. Chatterji,[1] for example, calculates the loss involved in the production of Soft Coke in India (about 2 million tons yearly) as follows :—

2 million tons of Soft Coke result in the loss of :—

0.75 million gallons of motor spirit
1.5 ,, ,, ,, light oils
3.0 ,, ,, ,, lubricating oils
0.75 ,, ,, ,, Carbolic acid and Creosote oil
10,500 tons of ammonia sulphate
12,000 tons of residual pitch

1 M. N. Chatterji, Proceedings of Indian Science Congress, 1945.

7.5 billion cubic feet of rich gas from which 50 million horse power can be developed.

The First Plan made a number of specific recommendations regarding coal :—

(i) Adoption of measures for conservation of metallurgical coal, restriction of output and enforecement of washing and blending and of stowing for conservation.

(ii) Detailed mapping of important coal-fields and assessment of reserves of material suitable for stowing.

(iii) Evolving a scientific classification for coal based on calorific value ash and moisture contents and coking property.

(iv) Stepping up of production from outlying fields.

(v) Research for washing, blending and carbonization of coal;

(iv) Legislation for the enforcement of stowing for conservation, washing and blending, consolidation of cesses.

(vii) Extension of use of Soft Coke for domestic purposes with a view to conserving cow-dung for manurial purposes.

Since the First Plan was set into implementation the following actions have been taken on the above recommendations :—

(1) With the passing of the Coal Mines (Conservation and Safety) Act, 1952, a positive step was taken for the conservation of metallurgical coal.

(2) Resurvey of Raniganj, Jharia and Bokaro Coal-fields has indicated substantially larger reserves of coal in these fields. Karanpura coal-field has revealed the existence of many new coal seams while Jhilimilli coal-field is expected to contain coking coal.

(3) In the interest of conservation and having regard to the need to supply coal of fairly uniform quality to the steel industry, the Coal Washeries Committee recommended the following measures :—

(a) All metallurgical coal down to grade II should be washed,

(b) the average cost of washing should be made good to the collieries through either revision of prices or a negotiated price for washed coal;

(c) washeries may be set up.

THE SECOND PLAN

As against a target of 60 million tons, production during 1960-61 has been 54.26 tons. Though the actual production had fallen short of the target yet the annual rate of production commensurate with the targets set for them. The production of coal increased from 32.31 million tons in 1950 to 38.23 million tons in 1955 and reached 54.62 million tons in 1960-61.

Coal Mines Act, 1952 (Conservation and Safety) was enacted to enforce conservation measures. Stowing was extended to cover conservation. Measures were adopted to regularise the production of coking coal with a view to conserve the limited reserves. Washing being one of the measures for conservation the Second Plan provided for additional washing capacity of 6.4 million tons to be achieved by the establishment of 4 central washeries and the installation of a washing plant at Durgapur steel plant. A capacity of 2.4 million tons has already been set up and the rest was done in the first year of the Third Plan.

Other conservation methods include a phased programme for the substitution of coking coal consumed by essential consumers by non-coking coal and provision for the grant of a special subsidy to mines handicapped by adverse factors, namely, gassiness, depth of working *etc.* Besides, steps are also being taken for the amalgamation of small and uneconomic collieries as recommended by the Committee on Amalgamation of Small Collieries.

INDUSTRIAL FUELS

The use of machinery in the coal industry is at a preliminary stage of development. In 1957, on an average, there were 458 coal cutting machines in about 155 mines which produced 23% of the total output. Also, there were 5 mechanical loaders and about 92 mechanical conveyors in operation.

The Progress of Coal Production in Five Year Plans

The Second Five Year Plan target of coal production in India was 60 million tons a year, out of which the shares of the public and private sectors were to be 15 million tons and 45 million tons respectively. The following table will show how far both the sectors have carried out their assignments :—

Year	Private Sector	N. C. D. C.	Singareni	Total
1959	40.33	4.48	2.22	47.03
1960	43.34	5.95	2.28	51.77

(Production in million tons)

During the 12 months ending 28th Feb. 1961, the coal out-put of the Private Sector amounted to 44.5 million tons—a mere half million tons below its target. By the end of March, 1961, it reached its target. It is learnt that the National Coal Development Corporation has exceeded the Second Plan target rate of production. During the last quarter of the last year of the Second Plan period (January-March 1961) the rate of production of coal was 13.7 million tons a year as against the target of 13.5 million tons. Singareni has already exceeded its

target rate at the end of 1960. Thus the total of 60 million tons at the end of the II Plan has been achieved by all means.

The Third Plan target of coal raising was fixed at 970 lakh tons (985 lakh tonnes) per annum by 1965-66 and additional output of 367 lakh tonnes. Of this, the private sector was allotted 173 lakh tonnes and the public sector 203 lakh tonnes. The fieldwise distribution of the additional production of both private and public sectors programmed together is given in the table below.

TABLE XCVI : *Fieldwise distribution of additional Production of Coal (Public and Private Sectors)*

	Million tons			
Fields	Coking	Blendable	Non-coking	Total
Bengal-Bihar				
Raniganj	0.35	1.62	8.66	11.63
Jharia	5.84	—	—	5.84
Bokaro	1.68	—	0.33	2.01
W. Bokaro	0.50	—	—	0.50
Ramgarh	1.50	—	—	1.50
Karanpura	—	—	0.42	0.42
Madhya Pradesh				
Pench-Kanhan	—	—	3.43	3.43
Bisrampur	—	—	2.50	2.50
Charcha Jhitim	—	0.50	0.50	1.00
Singrauli	—	—	2.50	2.50
Korba	—	—	1.50	1.50
Maharashtra				
Kamptee	—	—	1.50	1.50
Orissa				
Talcher	—	—	2.50	2.00
Andhra Pradesh				
Singareni	—	—	3.00	3.00
Total	9.87	2.12	26.34	38.33

COAL TRADE

India has a very limited home market for coal. Ceylon, Burma, Pakistan and the Far Eastern countries are the only important markets outside India. Our export trade in coal is, therefore, insignificant.

In 1957 we exported coal to the tune of 1,625,000 metric tons (worth Rs. 49,678,000), and in 1958 our exports of coal amounted to 1,741,000 metric tons (worth Rs. 53,329,000). The exports of coke from India amounted to 72,783 metric tons and 80,047 metric tons in 1957 and 1958 respectively.

The high cost of land transport which our coal must bear, if it is to be exported; and the general industrial backwardness of our neighbouring countries, which limits the demand for our coal, are some of the factors in our backward foreign trade in coal.

The largest market for our coal is the home market. This market is, however, negligible. India is a hot country where the demand for domestic-heating, common in Europe or America, is not important. The backward industrial development of India is also a factor in this smallness of the market for coal in India. The result is that the per head consumption of coal in India in normal years is not even one-thirtieth of that even in such a country as Canada. The following table gives the per head consumption of coal before the war :—

Great Britain	3.9 tons
Belgium	3.9 ,,
U.S.A.	3.3 ,,
Canada	2.2 ,,
Germany	2.0 ,,
India	0.07 ,,

About 40% of the coal produced is consumed by manufacturing industries and about 32% by railways. The backward state of our industries limits the production of our coal, because more coal will be produced if there is a demand for it. A profitable source of the demand is the domestic use of soft coke for coaking purposes. It has been noted that practically nine-tenth of our coal is inferior in quality from which only soft coke can be manufactured. This soft coke can be used best in our homes as domestic fuel, releasing the cow-dung which is a valuable manure rather than fuel. We have also seen that the wood fuel is limited in supplies in India. It will, therefore, be best for the coal trade which can then give more employment for our railways which will get more business; and for our agriculture which can get more cow-dung for manure, if we used more and more soft coke as fuel in the home.

Owing to the efforts of the Indian Soft Coke Committee about 9 lakh tons of soft-coke were supplied to the market in 1939 from the Bengal and Bihar coal-fields. The amount rose to 13 lakh tons in 1952. In the opinion of this Committee if the railways charge lower rates on soft coke it can easily compete with wood and charcoal in cheapness. The use of soft coke increased from 1.1 million tons in 1950 to about 1.6 million tons in 1955-56.

While coal has been exported from India for 200 years or more, it was the development of the ocean steamship during the nineteenth century that gave rise to the Indian coal trade of modern times. Steamships arriving from East and West in Bombay filled their bunkers with the high grade steam coals of Mohpani and Singarni. Many of these ships were tramp steamers bringing to India and nearby lands full cargoes of grain, ores, many other foodstuff and metal manufactures *etc.* Between two great World Wars of 1919 and 1939 Indian Coal exports increased.

Of the total production of Coal only about one third is used by the railways and the rest by industries or thermal power stations. About 8% of coal is also exported to neighbouring countries.

The following table gives the raising and utilization of coal in India after independence.

TABLE XCVII : *Trade and Utilization of Coal.*

(All figures in thousand tons)

Year	Total Raisings	Total Coal Despatches	Exports	Total Internal consumption after despatches	Consumed by electricity generation
1948	29,820	25,850	2,223	23,627	1,920
1949	31,490	28,050	900	27,150	2,090
1950	32,300	28,820	1,251	16,569	2,245
1951	34,450	29,120	1,400	27,720	2,340
1952	36,300	30,800	2,200	28,600	2,570
1953	35,850	31,050	1,200	29,850	2,785
1954	39,880	31,920	900	31,020	2,680
1955	38,409	33,280	1,570	—	—
1956	39,430	34,960	1,730	—	—
1957	44,200	38,895	1,625	37,092	3,465
1958	46,065	41,038	—	39,329	4,007
1960-61	60,000	56,000	1,000	55,000	5,200

The inferior quality coal is not suited to the manufacture of by-products. It is only from the coal from which hard coke, suitable for smelting, is manufactured that some by-products are obtained at present. These by-products are coal-tar and ammonium sulphate. The former has a large market in Calcutta and the latter is mostly exported to Java.

Unlike the coal in U.S.A. and Europe, Indian coal occurs in regions which are not endowed with facilities of water transport which

is the cheapest method of transporting coal. There are no canals or navigable rivers in the chief coal-producing regions of India. The scarcity of even drinking water is a feature of these regions which is a source of great inconvenience to the people working in the mines.

Both in Raniganj and in Jharia underground fires are causing a great damage to the coal and are a cause of serious colliery accidents, apart from reducing our resources in coal. At present, according to mining experts, the coal town of Jharia is seriously threatened with extinction in the near future by these underground fires which attack it from three sides—Pure Jharia, Khas Jharia and Suratar collieries. The Kuresea mine of the National Coal Development Corporation in Madhya Pradesh which employs 5,000 workers, and whose monthly output is about 50,000 tons of high volatile quality coal, has also been closed due to underground fires. The mine is now being sealed which is expected to cost about Rs. 1 lakh. The colliery is estimated to have a reserve of 50 million tons of coal. Sand-stowing or filling the affected part of the mine with sand, is the best method recommended for putting out these fires. Owing to the expense involved, however, our mine-owners are seldom willing to follow the practice. They generally seal the portion of the mine which is affected by underground fire and stop work in that section.

Indian railways are the largest consumers, taking nearly 31% of the total production of the country. Of this about 40% is coking and semi-coking coal. The colliery consumption which includes consumption in boilers, power plants in the mine premises and domestic coke for the staff is of the order of 11% of the total production—Of the total production of metallurgical grade coal, the railways consume about 40% the iron and steel industry about 21%, about 13% is used for bunker and export and the balance is consumed by miscellaneous industries.

Both Orissa and West Bengal have enough coal for their own needs. Coal is found in all four states of India, but 95% of the bituminous coal is mined in Orissa, chiefly near the steel-making centres of Jamshedpur and Asansol.

The Sone Valley and Chhattisgarh are by far the most important coal producing area in the Indian Republic. High grade bituminous coal, including coking coal, accounts for 40% of total reserves and the remainder consists of lignite.

The southwestern of these eastern coal fields is in Talcher west of Cuttack. It is accessible to adjacent markets and hence has greater development than any field south of Hazaribagh. This coalfield and the nearby deposits of iron ore and limestone are the basis of Rurkela's Steel Industry.

Raigarh, Mand river valley, Korba Himgir and Pench Valley constitute a coal field that is fifth in importance only to that at the head waters of the Mahanadi. The bituminous coal is not as good in quality

as that of the Damodar valley fields, but it is better than most of the coal of Wardha valley, and its nearness to Balaghat, and the manufacturing centres of Bhilai and Raipur makes it the chief supplier of this region.

The Satpura coal has long provided power for the cotton textile mills of Bombay and nearby towns. The varied coals of Mohpani Sonada and Shapur support huge cotton and textile, gas, cement, chemical, electric power industries, Potash, Drugs, Sugar, Hydrogenated vegetable oil and Royan industries in Bombay, Surat, Ahmadnagar, Poona *etc*. Pench coal fields support a similar industrial development around Nagpur.

Consumption

The approximate quantity of coal consumed by the principal consumers in India during 1958 was as follows :—(in million tons)

Railways	14.861	Paper mills	0.635
Iron and Steel plants	4.251	Jute mills	0.393
		Brick burning Works	1.792
Electric Supply Cos.	4		
Cement factories	2.2	Chemical factories	1.092
Cotton mills	1.834	Indian bunkers	0.150

In November, 1939, however, the Coal Mines Stowing Board was constituted by the Government for the purpose of putting out these underground fires. The activities of the board are financed from the proceeds of an excise duty levied on coal raised from mines in India, except those in Assam.

As coal is by far the most important and the cheapest fuel, it goes without saying, therefore, that the modern industrial development cannot take place without coal. Coal is needed for manufacturing armaments and munitions, battleships, tanks, guns, machine-guns, aeroplanes, bombs, and shells, which must be manufactured for the modern war and various types of heavy machines. All this cannot be done without coal. For these manufactures raw materials and workers from long or short distances must be transported. Finished products must then be transported from the factory to the field where they will be needed by the soldiers. Most of this transport depends on coal mining which is the most important branch of mining industry in the country, as will be seen from the number of persons employed in mining in 1953 given in the following table :—

Employment in Mines (No.)

Mineral	1953	1957	1958
Coal	3,41,193	3,70,244	3,82,172
Manganese Ore	1,10,869	1,10,214	86,857

Iron Ore	..	..	..	30,396	40,345	43,171
Mica	..	..	..	30,871	35,267	33,548
Gold	..	..	..	22,884	17,089	16,839
Others	..	..	..	—	78,162 [1]	86,773
Total	..	..	..	—	6,51,321	6,49,360

PROBLEMS OF COAL

One of the most important of the problems of the coal industry has been transport over the past several years. The continuing and persistent inability of the railways to provide an efficient transport network on a national scale has made it impossible for the coal industry to exploit its natural marketing conditions.

Next in importance comes the very much enhanced labour costs, for in coal mining labour costs account for approximately two thirds of the coal industry's cost of production and it has been calculated that the decision of the Tribunal appointed to adjudicate on the demands of the miners on an all-India basis has enhanced labour costs by another Rs. 15 per ton.

The problem of coal is its enormous increase in the cost of production. This increase in the cost of production is due to various factors, such as high labour cost, increased costs of machinery, compulsory amenities to be provided to the labourers and a variety of taxes.

QUESTIONS

1. Discuss the distribution and production of coal in India. (A. V. 1961)

2. "In spite of the growing importance of mineral oil [illegible] as sources of power, coal has come to stay as a vital factor in [illegible] of certain industrial centres". Comment upon this statement, [illegible] major industrial centres of India.

1 Including small-mines.

CHAPTER 18

Power Resources : Petroleum

Power, heat, light and lubrication *etc.*, are the chief uses of petroleum today. While many products are derived from petroleum at present, none renders a great service to mankind than the oils and greases that are used to lubricate the countless moving parts of modern machinery.

The major developments in the industry during recent years have been the establishment of production facilities for a wide range of by-products like gasoline, gas, asphalt, coke, paraffin, wax, canning wax *etc.* The steady increase in this demand has greatly increased the value of these oils, to great improvements in refinery practice in order to obtain the highest possible quantity of Petrol from both heavy and crude oils. As these uses have been admirably summarized by an American Petrologist in the article on "Petroleum in the World Atlas of commercial geology", published by the United States Geological Survey, the following quotation is submitted :—

"Petroleum is used chiefly as a source of power, light and lubricants, and these are the uses that every one knows. Crude petroleum is used in decreasing quantities from year to year; more and more of it is prepared for higher utilization by breaking it up into refined products of greater value. The number of these refined products is almost countless, and their uses are as varied as the needs of mankind. The light gravity ethereal products are employed as local anaesthetics. The gasolines are the universal fuels of internal combustion engines. The naphthas are extensively used as solvents and are blended with raw-casing head gasoline to make commercial gasoline. The kerosenes, though used chiefly for illumination, are employed in increasing quantities as fuel for tractors. The lubricating oils and greases are indispensable to the operation of all kinds of machinery. The waxes derived from petroleum of paraffin base are utilized in many forms—as preservatives, as sources of illumination, and as constituents of surgical dresssings made for the treatment of burns. Petroleum coke, an almost pure carbon, is used in metallurgy and in making battery carbons and arc-light pencils. Fuel oils obtained as by products in refining petroleum are used for generating power by industrial plants, railroads, and ocean steamers, Road oils are employed to lay the dust on streets and highways, and artificial asphalt, a product of petroleum, has in some

places been used for paving". In this way oil is the basis of modern civilization.

Occurrence of Indian Petroleum

The workabe deposits of Petroleum are confined entirely to sedimentary rocks which have suitable structures. Most of the Peninsular India consists of granites, metamorphic rocks or ancient sediments which do not contain Petroleum, we should, therefore, look for petroleum only in the regions around the borders of India, where extensive sedimentary formations occur. Amongst sedimentary rocks particular attention is paid nowadays to those of the tertiary age, because the majority of petroleum occurrences in the world are in tertiary sediments. Figure 40 shows the possible occurrences of petroleum in India.

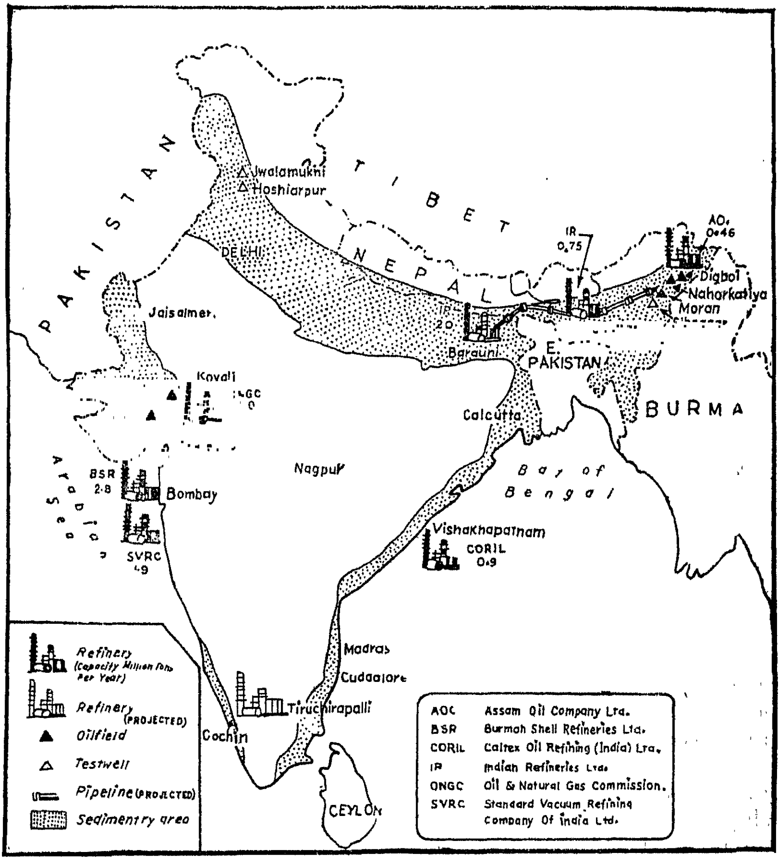


Fig. 40. Occurrence of petroleum in India.

Such rocks are found in India along the southern margin of the Himalayas and also on both sides of the chains along the Sind-Baluchistan border and the Assam-Burma border. Those of the Himalayan region are highly folded, broken up and thrust over each other, and it is doubtful if any important oil deposits will be found in them, except isolated structures.

In North Eastern India, oil has been successfully won in the Digboi and Badarpur fields and to a restricted extent and for short periods in the Masimpur and Patharia fields. The Digboi field is the only one still under production whilst the Badarpur field has been abandoned since 1933. At present the entire output of India comes from the Digboi field which has been producing for over four decades. It is, however, showing definite signs of declining output during the last decade. In the meanwhile, a considerable amount of drilling has been done in Upper Assam. This area is separated from the Digboi field by the well known thrust fault called the Naga thrust, but is entirely covered by thick alluvium and late tertiary sediments.

The present production of Assam (*i.e.*, of India) is of the order of 63 to 75 million gallons per year. This output is refined in the refinery at Digboi which handles about 4,500 to 5,000 barrels of crude oil per day. But it satisfies less than 10% of India's requirements in petroleum products. The rest, therefore, has to be imported at a cost of about 70 crores of rupees per year. It is, therefore, not surprising that considerable interest is being taken to try to find new sources of petroleum within India.

The most suitable geological formations for the search of sources of oil in India are the tertiary areas. Search in the Himalayan region, is not likely to be encouraging, as already mentioned in Upper Assam. however, geological conditions are somewhat more encouraging, though even here the tertiary formations have been subjected to much thrust faulting from the side of Burma.

In addition to these, there are comparatively small areas along the coast where there are patches of sedimentary rocks which may possibly contain oil. On the western side of India, the region of Jaisalmer, Kutch and Gujarat have possibilities because they contain mesozoic and tertiary sediments of some extent and thickness. Along the eastern coast of India, there are only small areas which include the Mahanadi delta and some tertiary rocks on the Madras coast. It is not known, however, whether these contain any suitable structures for acting as reservoirs of petroleum but suitable geophysical surveys can be made for finding out the possibilities.

It is generally known that an oil company is now prospecting in a part of the Ganges Delta in West Bengal. It seems likely that the alluvium which covers the delta region is underlain by a sufficient thick-

ness of tertiary rocks for the accumulation of petroleum. It is, however, too early to say what success will attend the prospecting operations.

It is necessary to sound a warning here. Even if structures suitable for acting as reservoirs for petroleum are located, this does not necessarily mean that petroleum will be found even in regions proved to contain oil, the statistical average is that only one out of 25 to 30 petroleum wells (drill holes) is successful in striking oil. It is, therefore necessary to bear in mind at all times that petroleum prospecting is a very risky venture, in which huge sums of money, much technical skill and complicated scientific equipment are involved and the chances of success are comparatively small. The chief oil companies of the world spend colossal sums of money annually on prospecting but only a small fraction of it yields a return. But when a good oilfield is struck, it can give large profits and wipe out the losses incurred previously.

AREAS OF CONCENTRATION

The Petroleum resources of India are confined to the two systems of folded rocks at either end of the Himalaya and are—

(1) The Iranian system on the west, including the Punjab and Baluchistan and continued beyond Persia and Mesopotamia, where the oilfields have attracted interest for many years.

(2) The Arakan or Shan system on the east, including Assam and Burma, with their Southern Geotectonic extension to the highly productive oilfields of Sumatra, Java and Borneo.

In both the areas oil is associated with tertiary strata, and has had probably similar conditions of origin in both cases. In Burma it is known to occur in beds of Nummilitic age, but by far the greater number of seepages and all the fields of importance are in the next highest geological series, to which there is every reason to suppose the oil is indigenous. In Assam oil is found in a similar series. The series of earth-folds in which this corner of Assam occurs stretches southwards to Cachar, where oil springs are also known, through Lushai Hills into Arakan. In the same system of parallel folds occur the oil fields of the Arakan Coast on the one side, and those of the Irrawady valley on the other.

Oil-springs are found in various parts of Assam, the most prominent being those at the Southern foot of the Khasi and the Jaintia hills, and those appearing in the coal-bearing rocks in north-east Assam, specially in the Lakhimpur district. Oil is also obtained from the Lakhimpur district, where systematic drilling is conducted at Digboi. The Digboi field covers an area of 5 square kilometres. Here the important oil centres are Digboi, Bappapaung and Hansapung. In the Surma valley some oil of poor quality is found in Badarpur, Masimpur and Patharia.

In the Punjab on the other hand it is the nummulitic which is the predominant oil-yielding series, and although the only supplies which have so far proved of economic importance are found in the series above, there is good reason to suppose that the oil has migrated up from the Nummulitic below.

In many parts of the Himalaya, however, and in the Punjab area the rock-folds have been too deeply truncated by agents of denudation or have been dislocated by earth movements, and much of the original stores of oil have disappeared; oil springs are common enough, but most of them seem to be mere "shows" not connected with reservoirs that can be tapped by artificial means.

As it was previously stated that occurrence of oil is known to be related to sedimentary areas. It has been estimated that the extent of sedimentary areas in India is nearly 800,000 square kilometres. This vast oil potential is distributed roughly as follows :—

		Area In square Kilometres
(1)	Assam including areas in which concessions are held by the Assam Oil Company, Tripura and Manipur	60,000
(2)	West Bengal and adjoining regions *i.e.*, Coastal regions of Orissa and Sundarbans	60,000
(3)	Western Himalaya including Punjab, Himachal Pradesh, Jammu and Kashmir	100,000
(4)	Rajasthan	93,000
(5)	Cambay Cutch	139,000
(6)	Ganga Valleys	284,000
(7)	Madras Coast	34,000
(8)	Coastal Regions of Andhra Pradesh	19,000
(9)	Kerala Coast	12,000
(10)	Andaman and Nicobar Islands	6,000

LOCATION OF FIELDS

In North Eastern India, oil has been successfully won in the Digboi and Badarpur fields and to a restricted extend and for short periods in the Masimpur and Patharia fields.

DIGBOI FIELD

Oil springs are known in various parts of Assam, the most prominent being those appearing in the coal-bearing series in North-East Assam, especially in the Lakhimpur district, and those at the southern foot of the Khasi and Jaintia Hills. Marketable oil comes from the Lakhimpur district where systematic drilling has been conducted at Digboi during the past sixty years by the Assam Oil Company, Limited.

The Digboi field was discovered in 1889 and until 1921 the production was less than 20,000 tons per annum. Thereafter it rose to over a quarter of a million tons. Most of the producing sands are in the Tipams stage of Miocene to Upper Oligocene ages.

The oil is of mixed paraffin and asphalt base with an average specific gravity of 0.850 (0.832 to 0.879)[1] and yielding excellent paraffin wax, lubricating oils and some bitumen. The total production from Digboi was estimated at over 7.5 million tons of crude oil in 1960.

BADARPUR FIELD

The second discovery of importance in Surma valley was the Badarpur field, which crosses the southern side of the valley, with its centre of Badarpur and Patharia. Both Badarpur and Patharia are situated on lightly folded asymmetrical anticlines with major thrust cutting the steeper flanks. About 60 wells were drilled here and the field was producing only between 1915 and 1932 yielding about 20,000 tons annually. The output of the Badarpur oil field was never a very rich one. This field is practically exhausted. Its present annual output is less than 1000 tons annually.

PATHARIA AND MASIMPUR FIELDS

The producing sands here being at the depths of 450 to 1848 metres. The oil is mostly shale oil. The Patharia and Masimpur fields in spite of much attention and drilling expended on them, have given only a very small output expended on them, have given only a very small output.

NAHORKATIYA OIL FIELD

In the Naga region of Assam, which is the only oil producing area in India, the full stratigraphic succession is exposed along the Naga thrust, in a gentle anticline in the Barails.

Nahorkatiya field has been estimated to yield 2.5 million tons of crude oil a year for a period of 20 years and the others *i.e.*, Moran and Hugrijan might also produce substantial amount of oil.

Oil has been discovered by the ONGC in Rudrasagar and Lakwa near Sibsagar in Assam. Trial production of 100 tons per day is to start from Rudrasagar from the middle of 1966.

WESTERN REGION

The development of petroleum in the Cambay lies chiefly in the future, for this region is least accessible to the nations leading markets. Many producing fields are scattered throughout this western region, which extends from Rajasthan to the Maharashtra border. Cambay has the largest proved reserves in this region. As a consequence of

1 J. Coggin Brown, *India's Mineral Wealth*, 1932.

new exploration and deeper drilling, production in the western Region particularly in Cambay has trebled since 1957. Fortunately, thousands of hectares of oil land are owned by the union Government of India which may render great service in future.

West Bengal

During the year 1957 West Bengal struck it rich with the discovery of a big oil field. This was followed by the discovery of Sibsagar. With the exception of its south-eastern corner, the state of West Bengal is poorly endowed with petroleum.

Production

India's production of petroleum was only 0.5 million tons per year in 1960; it increased to 40,000 tons in 1961-62, to almost a million tons in 1963-64. It is expected that ONGC will produce about 3 million tons by 1967 and about 10 million tons by 1970.

Oil India has made comparable progress. It is already producing about a million tons and will produce about 10 million tons by 1971. The North Eastern part of Assam includes the country's two principal oil fields—the Digboi and Makum, each of which contains a number of producing wells. From these two fields 80% of India's domestic oil supply is derived. The Digboi field has been increasing in importance since 1955, its output being from 60 to 65% during the period 1955-56. Producing centre in North East Assam other than Digboi and Makum are few and very important.

The following table shows the production of petroleum in India in comparison with some other principal countries.

TABLE XCVIII : *Production of Petroleum of the World.*

Country	Production in 1000 metric tons 1959	1960	1961
U.S.A.	347,100	347,121	353,500
Venezula	146,573	147,863	151,000
U.S.S.R.	129,500	147,000	166,000
Kuwait	695,30	80,600	81,500
Saudi Arabia	41,750	61,500	69,000
Iraq	45,570	45,500	47,900
Iran	13,700	52,000	60,000
Mexico	18,215	14,125	15,200
Indonesia	114,37	20,592	20,600
Romania	7,581	11,550	11,582
Columbia	—	7,864	7,500

India	420	449	500
Pakistan	319	364	388
Burma	500	532	542
Egypt	3,076	3,272	3,700
U. K.	84	87	105
France	1,622	1,918	2,170
Canada	24,875	25,827	30,700
Japan	400	527	650

A new oil field around Naharkotiya, Hugrijan and Moran, about 20 miles (32 kms.) south-west of Digboi was discovered in 1953. It is estimated to yield 2.5 million tons of crude oil a year for a period of 20 years and Moran and Hugrijan might also produce substantial amount of oil. In all, 48 wells have so far been sunk in this region out of which 40 are oil-producing. The capacity of these wells might eventually go up to 4.5 million tons.

Actual drilling for oil has been carried out by the Oil and Natural Gas Commission at Jwalamukhi Hoshiarpur, Vadeser and Cambay and by the Indo-Stanvac project in West Bengal.

In Cambay at Lunej, a promising oilfield was discovered at a shallow depth of 5,368 ft. Oil has also been struck at Vadeser and Ankaleswar near Baroda.

Oil exploration anywhere is full of uncertainties and risk. It is perhaps more so in India under the existing conditions. Even the biggest oil companies carry out prospecting for 5 to 15 years before they abandon any area. In the U.S.A., only one out of every 9 'wild cat' wells, produced oils. Only one, out of 44 wells, finds an oilfield big enough to supply America oil for just 4 hours. The odds against finding a 50,000,000 barrel field are 991 to 1. In fact, nobody has yet been able to predict with certainty an underground reservoir for oil merely by surface prospecting. It is said, "Oil is where you find; only drilling can tell."

Oil Refineries

India's crude petroleum, domestic and imported, is refined in some of the plants one of which is capable of refining only a few thousand barrels a year. At the close of 1957, there were only three refineries in India, which had an annual capacity of about 4 million tons. Until about 1950 the petroleum industry was dominated by foreign firms importing refined products, but from 1950 an expansion of the refinery industry was so rapid that by 1960 from 40 to 50% of the nations total oil consumption was domestically refined. By early 1963 this had been raised to over 7 million tons. Government control of the oil industry since 1954 has resulted in still further expansions of the domestic capacity;

by 1950 a much larger percentage of the country's oil consumption was domestically refined than in 1954.

The plants are widly scattered both industrial and strategic reascns. Some are located in the extremity of Digboi and Gauhati (Nunmati) in Assam.

The greatest centre is in Trombay near Bombay which is estimated to have about half of the nation's crude refinery capacity and still higher percentage of the cracking and the actual capacity. The Standard Vacuum Oil Company at Trombay, which went into production in July 1954, has a capacity of 1.6 million tons in terms of import of crude oil. The Burma Oil Shell Refinery, Trombay, which has an annual capacity of 2.0 million tons of crude petroleum wen into production in January 1955. Its capacity has now been increased to 3.75 million tons.

Prior to India's First Five Year Plan the demand of the country for Petroleum and petroleum products was met by Assam Oil Co., at Digboi. The story goes back to 1899 when the company took back over the oil leases of both the Assam Railways and Trading Company and the Assam Oil Syndicate. Another important year was 1921 when the Burmah oil company assumed control. Since their refinery—the first in India—went into production at Digboi thirty five years ago, a steady supply of over a hundred different kinds of petroleum products has been maintained. Early in 1954, Digboi's output was 180,000 gallons a day. Consequent on the discovery of new deposits in the neighbourhood, the figure has risen to 350,000. The company has plans to increase production to 400,000 lakh tons per year.

The third refinery (Caltex Refinery) at Vishakhapatnam has a capacity of 750,000 tons of crude petroleum and costs Rs. 12.5 crores. The following table shows the principal refineries and their capacity.

TABLE XCIX : *Refineries with their Capacity*

Refinery	Annual Capacity
Burma Shell Refinery, Trombay	2.0 million tons
The Standard Vacuum Oil Company (Trombay)	1.6 m. tons.
Caltex Refinery (Vishakhapatnam)	750,000 tons.
Nunmati Refinery (Public Sector)	7.5 lakh tons.
Barauni (Indian Refineries Ltd.)	20 lakh tons.
Koyali Refinery (Public Sector)	20 to 30 lakh tons.
Proposed Refineries	*Proposed Capacity.*
Cochin Refinery	25 lakh tons
Madras Refinery	
Haldia Refinery	22 lakh tons.

All the three refineries produce motor-spirit, kerosene, high speed diesel oil, light diesel oil and bitumen. For the exploitation of newly found oil fields in Assam, two more refineries have been set up at Gauhati (in Assam) with a refining capacity of 750,000 tons and an outlay of Rs. 17 crores, and another at Barauni (Bihar) with a capacity of 20 lakh tons and a cost of Rs. 41 crores.

Another refinery in the public sector with a capacity of 20 lakh tonnes per annum is being set up at Koyali near Baroda in Gujarat by ONGC with financial and technical collaboration from the U.S.S.R. authorities to process crude oil of Gujrat region.

Steps are being taken to expand the Nunmati, Barauni and Koyali refineries up to 12.5, 30 and 30 lakh tonnes respectively by 1965-66. In April 1963 an agreement was signed between India and Phillips Petroleum Co., of the U.S.A. for setting up another oil refinery at a suitable side in Cochin area, which would have a capacity of about 25 lakh tonnes per annum.

A number of pipelines are proposed to be laid down to connect Gauhati and Siliguri, Calcutta Haldia and Barauni, Kanpur and Barauni and Gujarat oil fields with power stations and other consuming centres.

In still occupies a comparatively low place among the oil producing countries, and in 1963 turned out only below one per cent of the World's total supply.

During the Fourth Plan there may be some expansion of capacity in private sector. Together, they are intended to provide refinery capacity of over 28 million tons. The annual estimated saving in foreign exchange as a result of the additional refinery programme in the fourth Plan is expected to be about Rs. 750 m. in 1971.

Imports of Oil

It would be superfluous in these days to urge the claim that petroleum has to special consideration. Its well known ability to yield liquid fuel, lubricating oil, illuminating oil (Kerosene) and the lighter forms of petroleum spirit (petrol) sufficiently summaries its manifold uses.

It may also be noted that in India, as indeed in all parts of the world, the Universal demand for petroleum products is steadily rising, in consequence of their use in internal combustion engines for motor transport by road, and in light weight engines for all forms of aircraft.

Foreign mineral oil has to some extent been displaced by the domestic products, but consumption is still on the increase in India and there persists a large market in India for foreign oil. As Indian production is too inadequate to meet the growing requirements of the country, large quantities of mineral oil are imported from Iran, Bahrein Islands, Saudi Arabia, U.S.A., Sumatra and Singapore. The following table shows the requirements of petroleum during 1965.

TABLE C : *Requirements of Petroleum* 1965

End Products	Refineries in Private Sector	Refineries under construction (Public Sector)	Total Production	(000 tons) deficient or surplus
Kerosene	916	366	1282	−1378
High speed diesel	1064	514	1578	+1029
Motor spirit	1024	514	1537	− 414
Aviation Turbine fuel	—	189	189	+ 219
Aviation spirit	—	10	10	+ 43
Furnace oil	1619	311	1930	+ 823
Light diesel oil	511	208	719	+ 153
Bitumen	394	120	514	+ 114
Jute Batching oil	47	—	47	+ 33
Vapourising oil, mineral turpentine	46	—	46	+ 84
Solvent, paraffin oil lubricants	21	50	71	+ 338

In 1957, we imported oil worth Rs. 107 crores from Middle East and the U.S.A. The average annual imports of foreign mineral oil during the period 1960-62 to 1963-64 was amounted to about 90%.

RESERVES

It is interesting to note that Russian experts in 1956 established the existence of over 50,000,000 tons of oil in the Gujarat area. Oil India has established the existence of another 50,000,000 tons or more in Assam. Very big oil reserves were likely to be found in Assam and Gujarat. In the south of the Bay of Bengal there might be large reserves, according to the views expressed by British and Russian experts. Along the Cauvery coast and in Cutch there might be reserves. According to the latest indications, reserves in the Laccadive and other Islands were not large. One Russian expert has gone to the extent of saying that India should be able to produce about 150 million tons of oil a year within 20 years.

QUESTIONS

1. Give an account of the petroleum production in India. Point out the areas where petroleum has been found recently.

2. Describe the mineral oil resources of the Indian Republic.

3. "Location of large-scale industries has been greatly determined by the presence of coal but not of oil, whereas electricity has brought about complete dispersal". Discuss this statement, selecting specific examples from Indian union.

4. What are the foreign sources of supply of mineral oil for India ? Discuss the present position of such supplies and the prospects of increasing indigenous supplies from coal and molasses.

CHAPTER 19

Power Resources : Hydro-Electricity

India's resources of hydro-electric power are vast. These resources have not even been surveyed in their entirety. A committee was appointed which issued a preliminary report in 1919 and a final report in 1951 and indicated a minimum continuous water power potential in India of 3.5 million kw. This, however, is proved to be an underestimate. Projects not included in that Survey have since been taken up for investigation and some of them are in an advanced stage of development. There are no doubt other sites which have not yet been taken up for investigation. Power potential studies of the river basins of India indicate an aggregate hydro-electric potential of the order of 4 crore kw. at 60 per cent load factors, as follows :—

	Lakh Kw.
West Flowing rivers of Western Ghats ..	43
East flowing rivers of Southern India ..	86
Central India Rivers ..	43
Ganga Basin (excluding the potential in Nepal) ..	48
Brahmputra, Manipur and Tyao (excluding the potential in .. Sikkim ..	125
Indus ..	65
Total ..	4,11

Cheap electric power is essential for the development of a country. In fact, modern life depends so largely on the use of electricity that the quantity of electricity used per capita in a country is an index of its material development and of the standard of living attained in it. Apart from its use in industrial undertakings, electricity has a remarkable diversity of application. Electricity can provide cheap power for pumping water for irrigation and for numerous operations in agriculture and in the home. Extensive use of electricity can bring about the much needed change in rural life of India. It cannot only improve methods of production in agriculture and encourage cottage and small scale industries but can also make life in rural areas much more attractive and thus help in arresting the influx of rural population into cities. Comparing the position of India with some of the countries of the west, it is clear that the development of hydro-electricity here is insignificant.

The ratio between the total water power developed in various countries and their estimates of water-power is like this : Russia 34%; France 32%; Germany and Switzerland 54% each. Norway 53%; Canada 34%; Sweden 27%; U.S.A. 24% and India only 1%. This is but natural in the present state of industrial backwardness of the country. The basic importance of hydro-electricity for India must not, however, be lost sight of. Nature has not endowed us with abundant supplies of coal, but she has given us an abundance of "White Coal" whose supplies are inexhaustible in contrast with the supplies of coal which diminish as they are used.

The use of electricity in India is very limited at present. The average per capita production of electricity in comparison with some of the other countries is given in following table.

TABLE CI : *Per Capita Production of Electricity*

Norway	6503 Kwh.
Canada	4890 ,,
Sweden	3000 ,,
U.S.A.	2600 ,,
U.K.	157 ,,
Japan	715 ,,
India	30 ,,

The following table shows the per capita consumption of electricity in comparison with some of the other countries of the World.

TABLE CII : *Per capita Consumption of electricity Per Year in India and the world.*

India	28 Kwh.
U. K.	110 ,,
U.S.A.	2207 ,,
Canada	3905 ,,
Switzerland	2252 ,,
New Zealand	1519 ,,

The supplies of coal and oil fuels are deficient in India, but there is one fuel of which there is an abundance. This fuel is hydro-electricity. Unfortunately, it is very little harnessed in India, due largely to the industrial backwardness of the country. Heavy rainfall, rough topography to cause water to fall, and a regular and continuous flow of water are the three important geographical requirements for developing hydro-electricity. Of these the first two are found over a large part of India, but as regards the third, India is unfavourably situated. The seasonal distribution of rain and its precariousness tend to make the flow of water in streams very irregular. This necessitates making of high masonry

dams to create artificial lakes to feed the power-house regularly. The cost of hydro-electricity is, therefore, higher in India than it is in most other countries. The prices of coal in India are so low that most towns find it cheaper to generate electricity with coal than with water. This is particularly so in the towns of northern India which are easily accessible and are near the coalfields.

The progress of power production was very slow up to the mid-twenties. The aggregate installed capacity in 1925 was only 1,62,341 Kw.; by 1945, it had increased more than five fold to 9,00,402 Kw. The installed capacity of power plants in the public utilities in March 1964 was 62,28,000 kw.—an increase of nearly 239 percent since 1951. During the same period, the generation of electricity increased from 5,86,19 lakh kwh. to 25,50,000 lakh kwh. showing an increase of nearly 335 percent. The growth in steam, diesel, and hydro plant capacity during the period was 146,124 and 451 percent respectively. The progress of electricity supply in India during 1939-1964 in actual figures is shown in table .

TABLE CIII : *Progress of Electricity supply*

Year	Installed capacity of generating plants (000 Kw.)				Aggregate of maximum demand During the Year (000 Kw.)	Energy generated (Crore Kwh.)	Energy sold (Crore Kwh.)
	Steam	Diesel	Hydro	Total			
1939	541	87	442	1070	576	2.44	2.03
1947	757	94	508	1,363	886	4.07	3.36
1951	1,097	163	575	1,835	1,205	5.86	4.79
1956	1,596	228	1062	2,886	1,990	9.66	7.96
1960-61	2,436	300	1843	4,576	3,551	16.94	13.95
1961-62	2,466	317	2419	5,202	3971	19.68	16.45
1962-63	2,536	327	2916	5,779	4635	22.36	18.28
1963-64	2,699	354	3167	6,220	5220	25.51	21.91
1964-65 First half	N.A.	N.A.	N.A.	N.A.	N.A.	13.66	11.34

In India the commercial energy demand is mainly supplied by electricity 52% followed by coal 43% and oil 5% only the following table CIV shows the installed capacity by states in India.

TABLE CIV : *Growth and installed Capacity by State*

State	1950-51	1961-62	1963-64	1967-68
Andhra Pradesh	21	214	250	877
Assam	3	27	41	202
West Bengal	522	—	—	—
Bihar	45	1,062	1,160	2,989
Gujarat	438	338	401	780
Maharashtra	—	724	958	1761
J. and K.	6	21	26	82
Kerala	34	148	193	622
Madhya Pradesh	42	222	235	798
Madras	168	560	815	1855
Mysore	107	203	260	992
Orissa	5	164	310	560
Punjab	68	574	577	1222
Rajasthan	24	179	191	561
Uttar Pradesh	184	608	732	1541
Delhi	43	76	112	241
Himachal Pradesh	—	0.2	0.7	2.7
Pondicherry	—	4	4	—
Goa, Daman and Diu	—	5.3	5.3	5.3

The following table shows that Maharashtra has the highest installed capacity (885,504 Kw.) followed by Uttar Pradesh (765,368 Kw.), Punjab (689,556) and Madras (631,250 Kw.). The installed capacity in Assam is only 29,365 Kw. while Gujarat has 420,499 Kw. Bihar 81,474 and Mysore 257,696 Kw.

TABLE CV : *Installed Capacity in kw. for various States in India.*

State's	Steam	Hydro	Oil	Total
Andhra Pradesh	103,500	180,000	13,351	269,851
Assam	—	9,940	19,425	293,65
Bihar	58,770	—	22,704	81,474
Gujarat	355,600	—	64,899	420,499
J. and K.	1,500	29,252	1536	32,288
Kerala	—	192,500	1205	193,705
M. P.	174,000	92,000	28,090	294,090
Madras	101,500	529,750	—	631,250

Maharashtra	307,250	523,888	54,366	885,504
Mysore	11,100	230,400	16,196	257,696
Orissa	5,700	270,000	12,460	288,210
Punjab	18,100	654,836	16,620	689,556
Rajasthan	47,850	—	29,389	77,239
U. P.	380,710	341,970	42,688	765,368
W. Bengal	618,150	7,508	10,099	635,757
Delhi	91,600	—	22,630	—
Andaman & Nicobar	1,100	—	330	114,230
Goa, Daman & Diu	—	720	5562	1,430
Himachal Pradesh	—	—	270	5,562
Laccadive and Minicoy	—	—	141	990
Manipur	—	—	850	141
Nagaland	—	—	725	850
Pondicherry	—	—	—	725
Tripura	—	—	1,753	—
D. V. C.	420,000	104,000	—	52,4000

The statewise pattern of power development in India at present is as follows :

Mysore, Kerala, Punjab, Orissa, Jammu and Kashmir	..	Mainly hydro-electric.
Bihar, West Bengal, Gujarat and Rajasthan	..	Largely thermal.
Maharashtra, Madras, Andhra Pradesh, Uttar Pradesh, Assam, and Madhya Pradesh	..	Partly thermal partly hydro-electric.

The pattern of power development which has been visualised to emerge out will be one of inter-connected hydro-electric and thermal power stations in various regions—the regional systems ultimately culminating in an all-India grid.

The fig. 41 shows the Power Regions and their inter-connections. Two physical features of India, the predominance of mountain land and the abundance of precipitation, are responsible for large potential water-power. The volumes of flow of the short but vigorous Deccan rivers varies considerably, periodically with the seasons and non-periodically with spells of drought and extreme rainfall, for the country as a whole June, July, August and September are the months of maximum flow and available water-power; February to May are the periods of greatest deficiency. To provide for effective use of waterpower resources in the

face of the variable stream flow, a number of regulating ponds (especially in Maharashtra) and reservoirs have been established after independence.

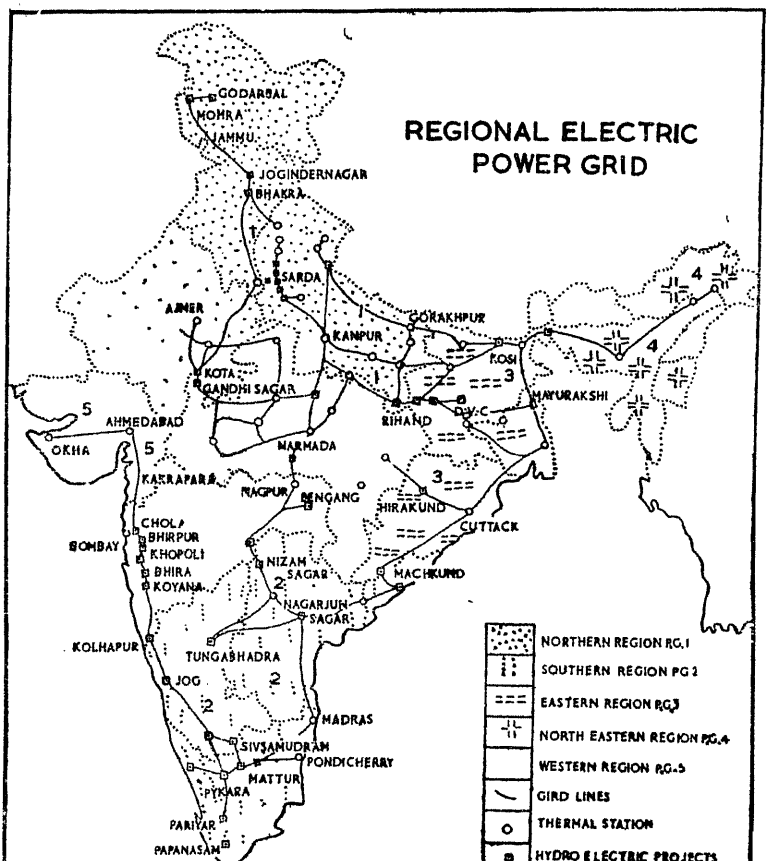


Fig. 41. Regional Electric Power Grid

India's natural waterways are more or less evenly distributed over the entire country. Decentralization of power plants, is therefore, a natural result.

In the hilly areas and in those parts of the Deccan tableland which are far away from coal, and where waterfalls are numerous, hydro-electricity is being developed where there is demand for it. The larger schemes of hydro-electricity came into existence in India during the first World War when the price of coal was very high and hydro-elc-

ctricity was, therefore, cheaper. The major Hydro-electric works are described in the following pages.

(i) *The Tata Hydro-Electric Works* which have their power-houses near Poona and supply electricity to Bombay. The water in the several lakes near Lonavla is harnessed and power transmitted to Bombay over a distance of about 112 kilometres by overhead wires. These lakes are shown in the following map. There are three power-houses at Khopoli, Bhivpuri and Bhira.

The normal capacity of the Power Station at Khopoli is 48,000 Kw. or 64,300 H.P. These hydro-electric schemes have a combined normal capacity of 246,000 H.P. and provide electricity for the city of Bombay and its suburbs, Thana, Kalyan and Greater Poona.

In Bombay there are three great hydro-electric works. The first, Lonavla works are situated at the top of the Western Ghats where rain water is stored up in three lakes—Lonavla, Walwan and Shirvata from where it is conveyed by canals and pipelines to Khopoli at the foot of the Ghats to generate power.

The Andhra Valley Power Co. is situated at Bhivpuri where rain water is stored by means of a dam across the river. The electrical energy is transmitted to Bombay over a transmission line 89 kilometres long for augmenting the supply from Khopoli.

The third work lies to the south-east of Bombay on Nila Mula river.

Besides the above Stations, the Central Ry. owns a small power station at Chola lake in the Western Ghats on the Ulhas river. The textile industry and the town of Bombay use this power. Thana, Kalyan and Poona also get electricity from these stations.

(ii) *The South Indian Hydro-Electric Works*, with their pivotal Pykara Works have an important significance in the economic life of the Madras State and Mysore. These parts of India are far away removed from coal. Most of the important towns are situated inland, away from the coast. The problem of industrial fuel is, therefore, a serious one. Unlike Bombay, the industrial towns of the interior cannot import coal cheaply. The progress of industry was, therefore, slow until the development of hydro-electricity solved this portion partly. The Pykara hydro-electric works was developed in 1932 on the Pykara river in the Nilgri district. Pykara is a household word in Southern India, because it has brought prosperity to a large part of the country. The Pykara site is one of the best for power development in the world, the ultimate capacity is estimated to be 100,000 h.p. Already with the completion of the present extensions the capacity of the plant is raised to 5,000 h.p. The increase in the demand for power in the Tamil country compelled the Madras Government to provide urgently further storage at Mukurti, and additional generating units. The increase in the demand for power

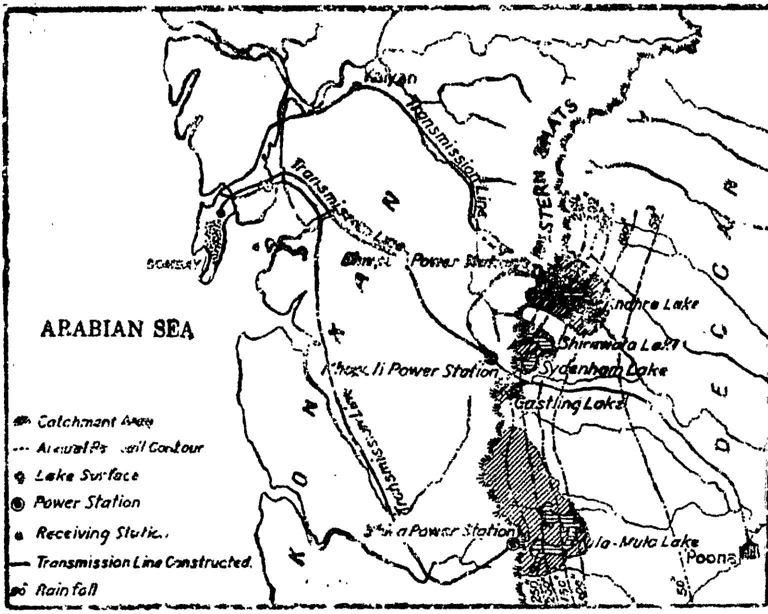


Fig. 42. Tata Hydro-Electric Works

was brought about generally by the rapid industrialisation of South India taking advantage of the availability of cheap electric power and particularly by the phenomenal development of the textile industry in Coimbatore. The power from Pykara is transmitted to Coimbatore, Erode, Tiruchirapoly, Negapatam, Madurai and Virudhnagar.

According to the plans of the Government the Pykara, Mettur and Papanasam Hydro-Electric lines have been inter-connected to and from an electric grid, because the development of textile and other mills at Mettur, with the help of the power generated there from the river Cauvery, was much beyond expectation, and it became clear that Mettur will not be able to meet the demand without assistance from Pykara.

This was especially so, because during the irrigation closure period, when water does not run in the canals, the capacity of the Mettur Generating Station drops from 45 000 K.W. to 60,000 K.W. The extension of the Pykara works has, therefore, been hastened.

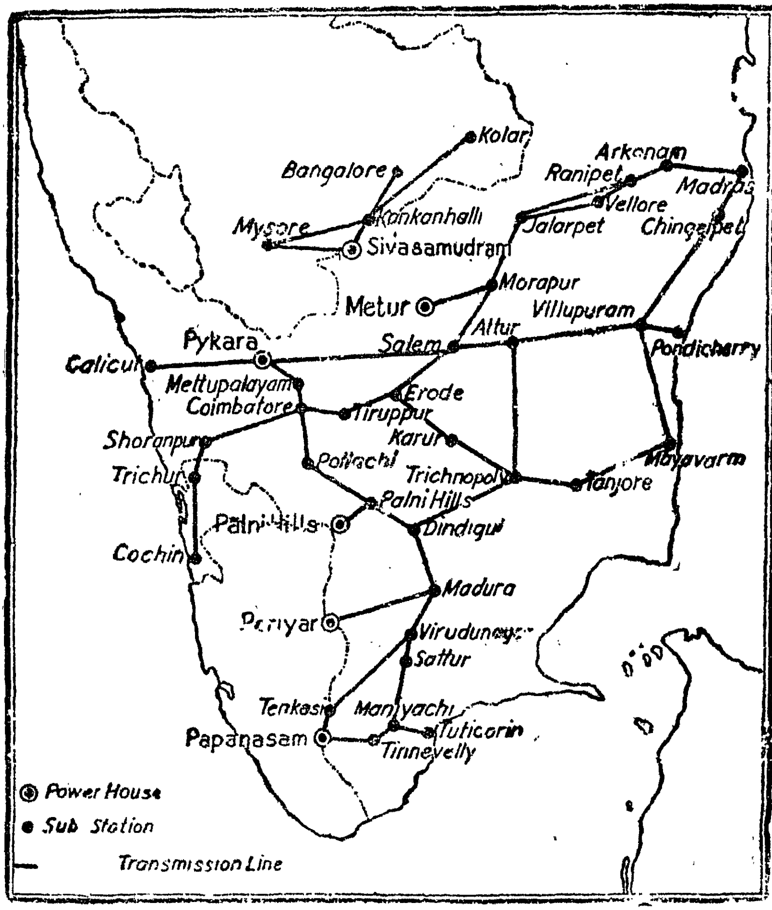


Fig. 43. The South-Indian Hydro-Electric system

The Mettur Dam on R. Cauvery makes a lake whose catchment area is about 32,000 sq. kilo metres. The Mettur power scheme provides the districts of Salem, Tiruchirapoly, Tanjore, North and South Arcot and Chittur with energy. This scheme is linked with Pykara Works at Erode.

In Madras there is another scheme on the Tamraparni river at the foot-hills of the Western Ghats above Papanasam in the Tinnevelly district which supplies power to Tinnevelly, Koilpatti, Madurai, Tensaki and Rajpalayam.

Madras has well developed the electricity services in its villages. In Madras the textile mills, cement factories, aluminium and steel works paper mills and railway workshops use hydro-electric power.

(iii) *The Sivasamudram works* were one of the first hydro-electric works to supply industrial power for use in the Kolar Gold Mines situated about 144 kilometres away. Sivasamudram supplies power to Bangalore. The toal annual capacity is 69,000 E. H. P. Near Mysore another dam has been constructed at the Cauvery making a lake known as "Krishnaraja Sagar." A small amount of power is generated at this dam and is used for working the sluice gates of the canals taken out for irrigation from this Sagar. This dam had been projected by Tipu Sultan, though it was not constructed in his time. The main purpose of Tipu's project was irrigation. The idea of electricity was unknown then. The Jog falls in Mysore are also being harnessed for electricity. These falls have now been renamed as Mahatma Gandhi Falls.

The normal capacity of the power station at Jog is 24,000 H.P.

(iv) *Always in* Kerala is an important centre for hydro-electric development in the south. The power station is producing about 1,09,500 kw. Out of its present production about 20,000 kw. are being sent to places situated in the Madras State. Most of the power generated at Alwaye is used in industries. The industries using the hydro-electricity of Alwaye are located at Trichur, Alwaye, Kottayam, Alleppy, Quillon, Trivandrum and Shencottai.

(v) *Outside the Peninsualar India, Mandi Hydro-Electric works* near Jogendranagar in the Simla Hills are important. The Mandi works were undertaken with very high hopes which have not been fulfilled. They supply power for lighting and domestic purposes to some of the towns in the Punjab. Kangra, Pathankot, Dhariwal, Amritsar, Moga, and Jullundhar, Gurdaspur, Gujranwala, Simla, Ambala are the chief among these towns. The supply is to be extended to Saharanpur, Delhi, Meerut, and districts of Karnal, Panipat and Rohtak.

The Mandi Hydro-Electric works have been started chiefly to supply power from the Uhl river in the Mandi State. This river is a small one (its catchment area is only 294 sq. kilometres) but carries a very large amount of water. The course of the river has been changed by building a dam across it. The waters impounded by the dam are then passed through a tunnel made in the opposite direction. This tunnel is 487 metres long. From this tunnel the waters are led by means of huge pipes to the electricity generating works situated below in the plains near Jogendranagar. The water falls from a height of 609 metres. The water, after its use in the works, is released for irrigating this plain.

The power is transferred by means of overhead wires through the hilly area of the Kangra Valley. Practically all the towns situated near the foot of the Himalayas in this section get power from these works. It will be seen from a map of India that most of the towns of the Punjab are situated in this region.

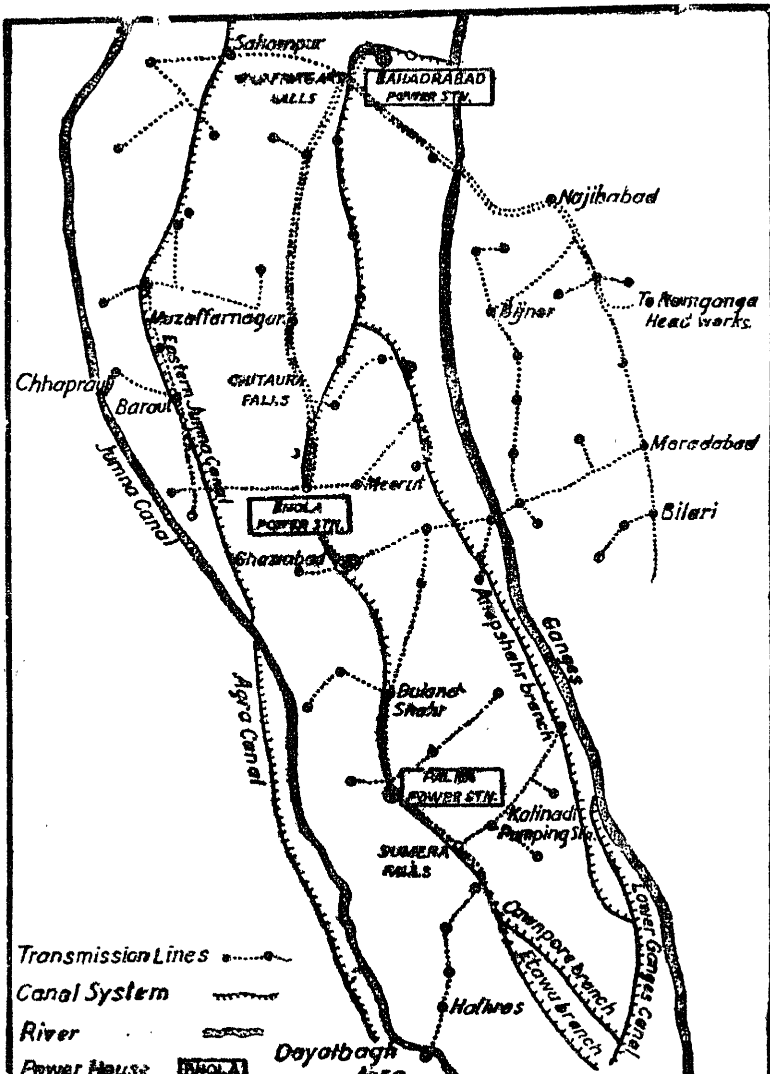


Fig. 44. The Ganga Canal Hydro-Electric System.

The works are handicapped in being situated far away from the populated area of the Indo-Gangetic plains. The means of communication are difficult. The company had to finance the working of the Kangra Valley Railway which was built by the Government of India

specially for the use of the works. This railway passes through the hilly area and is, therefore, very expensive to operate. The cost of transport of the material required by the works must, therefore, be very high. The Mandi area is not rich in any kind of industrial raw material. The works cannot, therefore, supply power to any industrial works near about. Their market is really hundreds of miles away.

The Punjab, however, which is the chief market for the Mandi works, is situated very far from coal. This fact alone makes it possible for the Mandi works to carry on profitably.

The Uhl river is producing now about 50,000 kw. Punjab gets about 10,000 kw. more from Nangal and Bhakra dams.

(vi) The Baramulla works in Kashmir must also be noted. The waters of the Jhelum river enter a gorge here and are utilized for generating electricity. The power is supplied to Srinagar and Baramulla.

The most important hydro-electric works connected with irrigation works are those on the Upper Ganga canal. The power is generated from several falls on the Ganga canal. The main power-house is at Bahadurabad, but the power generated at different falls is connected to a grid which serves the towns of western U.P. A map shows these falls and the towns served by the grid. The Power Stations are situated at Bahadurabad, Mohammadpur, Nirgajni, Chitaura, Salwa, Bhola, Plara and Sumera. The various power houses in Ganga Hydro-electric System is shown in chronological order below :—

Fall	Mileage	Drop in metres	Kw. generated
1. Bhola	84	4	2,700
2. Palra	148	3	600
3. Bahadrabad	14	5.5	4,400
4. Salempur			
5. Sumera	163	5.5	1,200
6. Salwa	67	5.5	3,000
7. Chitaura	56	5.5	3,000
8. Nirga jni	43	5.5	5,000
9. Asafpur			
10. Mohammadpur	31	2.9	9,300
11. Pathri	10	3.3	16,000
12. Rampur	5	4	—

The Ganga canal system produces generally about 45,200 kwh. of electricity every year. The area served is about 32,000 sq. kilometres spread over fourteen districts of U.P. There are about 95 towns receiving electricity from this system whose transmission lines run for more than

8000 kilometres. The greatest importance of this grid lies in the fact that it enafles extension of irrigation in certain areas which could not formerly be effectively served by the existing Anupshahr branch of the Ganga canal. Water is now pumped into this branch from Kalinadi with the help of hydro-electricity. A number of tube-wells have been bored and are now worked with electricity to supply irrigation water to areas which could not be supplied with canal water.

Two steam power stations were built at Chandausi (19000 kw.) in 1937 and at Harduaganj (10,000 kw.) in 1942, which enabled a grid to be formed of a total installed capacity 38,000 kw. (19,000 plus 9000 plus 10,000). It also provided facility for the closure of the Ganga canal, when necessary for the examination of works without seriously interrupting power supply.

It is being proposed to increase the capacity of the Harduaganj power station by another 10,000 kw. This power generated from falls on the Ganga canal is being used in running tube wells, flour mills, oil-crushers, rice husking machines. It also supplied energy to Meerut, Roorkee and Agra cantonments and arms factory of Moradnagar. It lights all the big railway stations lying in the Ganga Grid and provides electric energy to Aligarh University, Roorkee University, Government Workshop at Roorkee and Dayalbagh Workshop at Agra and to many other similar industrial concerns, both big and small. Nineteen electric companies in the Ganga Grid are also purchasing this energy and supplying for domestic use and other purposes.

It will thus be seen that to the western Uttar Pradesh Ganga Canal has been a boon and all its progress in commercial, agricultural and industrial fields is due to the Ganga Canal.

The other important power-generating works is the Sharda Power House. Situated in the Nainital district on the Indo-Nepal border, at the foot of the Himalayas and surrounded by thick forests its completion is a landmark in the development of the state of Uttar Pradesh. Constructed at a cost of Rs. 12 crores it supplies electricity for domestic, agricultural and industrial purposes to 150 towns and villages in eleven districts of the state. The Sarda service area comprises Nainital, Almora, Pilibhit, Bareilly, Shahjehanpur, Hardoi, Kheri, Sitapur, Lucknow, Unao, and Bara Banki districts. This 41,400 kw. power house is constructed at kilometre 0-9 of a new 19 kilometres long diversion channel in which a drop of 20 metres available in the Sarda Canal and spread over 18 falls, has been localised at a single place. This diversion channel offtakes in the 12 kilometre of the Sarda Canal. Three turbo-alternators each having a generating capacity of 13,800 kw. have been installed. The system has also been linked up with the existing Ganga Grid.

Most of the hill stations are situated in a region where waterfalls are numerous, and the means of communication difficult, so that the

transport of coal becomes expensive. These stations find it cheaper to develop hydro-electricity. Practically all the big hill-stations, therefore, developed their own power.

The richer areas in potential hydro-electricity have practically not been tapped. Assam, Orissa, Bihar and U.P. possessing more than one-half of the potential resources have practically not been exploited. About 80 per cent of the developed hydro-electric resources are in the Western Ghat mountains. Maharashtra, Madras, Mysore and Kerala draw their hydro-electricity practically entirely from these mountains. The total installed capacity of hydro-power in S. India is about 230,000 kw. although 2 million kw. can be made available. The reasons why the Western Ghats have been tapped for hydro-electricity to a larger extent than the Himalayas are as under :—

(1) The waterfalls situated in the Western Ghats are easily accessible, so that materials and machinery for developing hydro-electricity can be taken to them easily. (2) The rainfall in the Western Ghats is heavy and, therefore, there is no dearth of water for generating electricity. (3) The neighbourhood of the Western Ghats is industrially much developed and, therefore, there is a large market for electricity there. (4) At the same time, this region lacks coal. The work of coal is, therefore, taken from hydro-electricity. (5) This region is a broken plateau where there are naturally many waterfalls.

The power development during the past decade has proceeded in the direction of grid systems which carry power over long distances to serve extensive areas. The regional grids have been inter-connected with one another so as to provide an interchange of power and for achieving improved efficiency and economy, reduction in standby capacity and greater security of supply. The important examples of such interconnections in India are :

(i) The Pykara, Mettur, Papanasam and Madras City Schemes in Madras State;
(ii) the two tie-lines between Madras and Kerala State systems;
(iii) the linking of Jog (Mysore) and Tungabhadra (Andhra) system;
(iv) inter-connection of Nangal and Delhi power stations with a future possibility of connecting them with the western U.P. power system; and
(v) inter-connection of D.V.C.'s thermal and hydro stations in Bihar with the Calcutta City system.

MULTIPURPOSE PROJECTS

In post-Independence era, the various state governments have undertaken several power and irrigation projects in hand for execution. The projects are known as the 'Multi-purpose Projects'. These projects are so called because of the manifold benefits they yield. Apart

from providing irrigation facilities for additional food and commercial crops, the two other main benefits they confer are the control of floods and the generation of large block of hydro-electric power. Among the other benefits which accrue from such projects are the development of internal navigation (which relieves pressure on railways) pisciculture, the provision of drinking water and the eventual development of the rivers for the purposes of recreation.

At present, there are 153 projects under execution in different parts of the country. Of these 6 are multi-purpose; 140 irrigation and 43 power projects. Twelve of these 153 projects may be termed 'major.' Of the 'major' schemes 6 are multi-purpose, 3 power schemes and 3 irrigation schemes. In addition there are 122 other schemes on which preliminary investigations are either in progress or have been completed and further work is in progress. Eventually these projects will irrigate 22.0 million additional acres and generate 1.5 million kw. of additional power.

The following are the most important multi-purpose projects on which work is in full swing :

1. The Damodar Valley Project—in the Hooghly basin.
2. The Bhakra-Nangal Project of the Punjab.
3. The Hirakud Project of the Orissa river system.
4. The Tungbhadra Project of Krishna system.
5. The Kosi Project of the Eastern Ganga basin.
6. The Rihand Dam Project.
7. The Machkund Project.
8. The Kakrapara Project.
9. The Mayurakshi Project.
10. The Chambal Project.

1. *Damodar Valley Project*. Of all the projects the Damodar Valley Project is the most ambitious in outlook. For it aims not only at developing power, but also providing irrigation, controlling floods and malaria, introducing scientific management of land, promoting actively the economic development of the entire basin and improving navigability of the Damodar river. In fact, it aims at copying the famous T.V.A., (Tennessee Valley Authority) of the United States of America. The Damodar Valley Corporation was set up in July 1948 to execute the Damodar Valley Corporation. (D.V.C.).

The Damodar Valley Project is intended to control the Damodar river and its tributaries whose floods periodically cause considerable damage. It envisages the construction of a series of 8 dams with hydro-electric installations. The total areas to be controlled by all the dams is

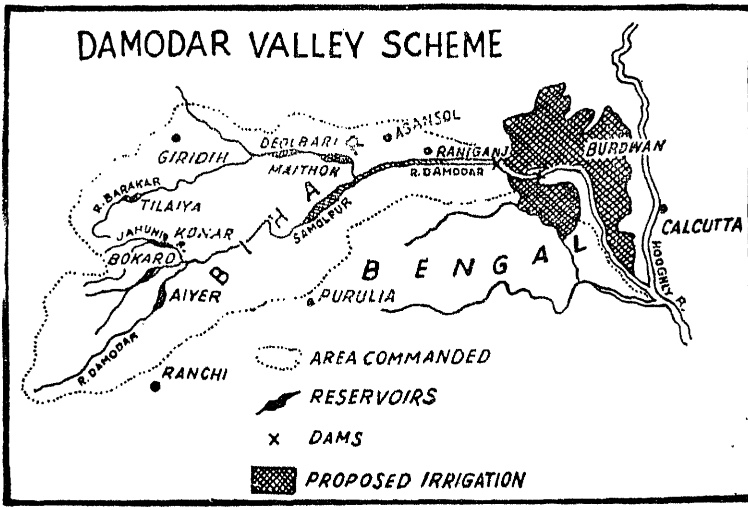


Fig. 45. Damodar Valley Scheme.

13,000 sq. kilometres and the water to be stored behind them will be 45 lakh acre feet. The total hydel energy to be generated will be 104,000 K.W. plus 500,000 lakh K. W. thermal power at Bokaro, Durgapur and Chandrapura. A network of canals and transmission lines to distribute the water and the power produced is also to be constructed.

Owing to the shortage of money, material, machinery, and men the scheme has been divided into two phases. The first phase on which work was started some years ago includes the construction of four dams at *Tilaiya*, *Konar*, *Maithan* and *Panchet Hill*, a thermal station at Bokaro, a transmission system of 752 kilometres, an irrigation barrage at Durgapur and a network of canals in the lower valley to irrigate over a million acres of land in the districts of Burdwan, Hooghly, Bankura, and 24 Parganas.

The Tilaiya dam is located on the Barakar river about 208 kilometres above its confluence with the Damodar. The dam is 340 m. long with a maximum height of 30 m. above the level of the river. Its 26 sq. miles reservoir will store about 320,000 acre ft. of water. This water will enable irrigation of nearly one lakh acres of land, *i.e.* 24,000 acres in the *kharif* and 75,000 acres in the *rabi* seasons. It was completed in 1955.

The power plant consists of two sets of 2000 kw. each with provision for an addition of a third set at alater stage. This power station serves Hazaribagh and Kodarma towns and the mica mines. Advance supply of electricity from the construction power-house at Tilaiya was given to promote land development in this area.

The Konar dam on the Konar river is situated about 24 kilometres above its confluence with the Damodar river. The dam will be 3869 m. long and 47 m. high. This dam is primarily intended to supply enough

cooling water to the Bokaro thermal station, and the generation of about 40,000 kw. of power and provide irrigation to 45600 hectares of land. It was completed in May 1954.

The Maithan dam is intended mainly for flood control. It is located on the Damodar, a few miles above the junction of the two rivers. The Maithan dam is nearly 396 m. long and 48 m. high. The reservoir formed by this dam has a controlled storage capacity of over 12 lakh acre ft. and about three-fourth of this capacity is reserved for flood-control. The storage available at Maithan will enable 108000 hectares to be brought under perennial irrigation. The underground hydro-electric installation has a capacity of 60,000 kw. The dam was completed in 1957, and in the power house two generating sets of 20,000 kw. each have been commissioned.

The Panchet Hill dam is approximately 547 m. long and stores 12 lakh acre ft. of water. It has a power-house with a capacity of 40,000 kw. The project will enable nearly 7 lakh acres of land to be irrigated.

Most of the land to be irrigated under the Damodar Valley scheme lies in the lower valley on both sides of the Damodar river. Although rainfall is plentiful in this region, agriculture suffers from a twofold danger—floods and failure of rainfall at the required time. With the construction of flood control dams at Maithan and Panchet Hills, this danger from floods will be eliminated and the stored water will ensure adequate supply during times of failure of the rainfall. An irrigation barrage 2,271 ft. long and 38 ft. high at Durgapur was commissioned by the President in 1955. It will divert the water into two main irrigation canals on either bank and the water will be fed to the fields through a network of canals totalling nearly 1,552 miles in length. The net irrigable area is estimated at over ten lakh acres, two-thirds of which lie in the Burdwan district and a quarter in the Hooghly district. Nearly 85 miles out of 1552 miles of these canals will be navigable. The left bank canal and its main branch is also designated to serve as a navigation channel providing as alternative means of communication between the coal-fields and Calcutta. The canal will have a minimum depth of 9 feet and will be capable of accommodating two lines of barge traffic. This will go a long way in easing the heavy congestion on railways.

The Bokaro thermal power station with an installed capacity of 1,54,000 kw. was completed in 1953. It is the biggest power station in India. The station is located just below the confluence of Konar and Bokaro rivers and ample supply of cooling water is assured by the Konar dam and also by a barrage across the river at the power station site. To keep down the cost of generation, coal supply to the power station will be from the Corporation's own mines and will be delivered through a 4½-mile aerial ropeway.

The need for the large thermal power-house at Bokaro arose to make up for the shortage of electricity in dry season. In dry season,

more and more water will be taken out from the canals for irrigation purposes leaving less water for producing electricity.

The hydro-electric installations at the various dams and the Bokaro thermal power station of the Damodar Valley Scheme will be linked by many transmission lines. Power will be distributed through an extensive network. The Loyabad-Sindri-Maithan section of the main transmission line (56 kilometers long) is complete. These lines are being completed urgently to distribute in the coal-field area 22,500 kw. of power which is being obtained from the Sindri Fertilizer Factory Power Station.

A special feature of the Damodar Valley Project is that benefits accrue as each component part is completed. Thus Tilaiya will provide water and assure full irrigation of the area now served by the Anderson Weir. With the completion of Konar there will be sufficient water to put the whole of this area under Rabi. Power is already being supplied to the Chittranjan Locomotive Works and the Kodarma Mica Mines. It has been estimated that the Damodar region will require about 3 lakh kw. But it will take some time before the full demand for power arises. The following diagrame gives a rough idea of the project.

The D. V. C. Scheme is enstimated to cost Rs. 103.93 crores.

The present programme of power generation envisages an installed capacity of 559,000 kw., out of which 375,000 kw. will be thermal and 184,000 kw. hydro electric. D. V. C. power has already reached some industrial areas such as iron and steel works at Jamshedpur, Burnpur and Kulti, the copper mines and works at Ghatshila, coal mines at Jharia and Raniganj, the Locomotive Works at Chittaranjan and many other industrial and commercial centres.

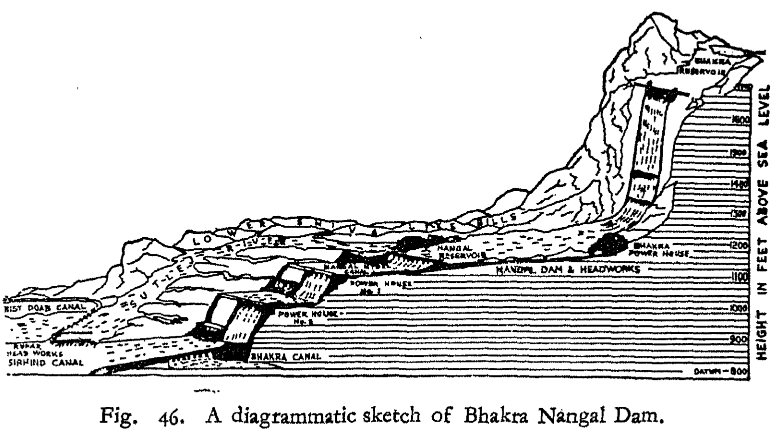


Fig. 46. A diagrammatic sketch of Bhakra Nangal Dam.

2. *The Bhakra-Nangal Project.* Though conceived in 1900 it was not until 1946 that this multi-purpose project was undertaken. It consists of:

(1) the Bhakra Dam 740 ft. high and 1700 ft. long and the width of base at its widest point is about 1,100 ft.—across the River Sutlej at the site of Bhakra Gorge, about 50 miles up-stream in Ambala district of the Punjab. This dam will form a lake 8 kilometres wide and 50 miles long—Govindsagar lake—the storage capacity of this reservoir is estimated to be 7.2 million cu. ft. of which nearly 5.5 m. cu. ft. will be available for hydro-electric power generation and irrigation purposes every year. This dam would rank as the highest straightway gravity dam in the world. During construction of the dam the river will be diverted through two 15 m. diameter diversion tunnels, one on the right and the other on the left, going through hill side. Each tunnel will be about half a mile long. It will have about 1020 kilometres of canals and over 3200 kilometres of distributories.

(2) The Nangal dam has been made across the river at Nangal, about 12 kilo. down-stream from Bhakra. This dam is a massive concrete weir 310 m. long, 121 metres wide and with its deepest foundation going down to 15 metres below the river bed.

(3) The above will divert the river into the Nangal hydro-electric canal. This waterway is about 64 kilometres long and 44 m. deep. It has been cemented throughout its length. The dam will serve as a balancing reservoir for taking up daily fluctuation from the Bhakra dam and for meeting daily and weekly load variations or power-houses on the Nangal hydro-electric canal.

(4) Two power-houses—one at Ganguwal 19 kilometers away from Nangal and the other at Kotla—6 kilometers off from Ganguwal. This system will supply power to Rupar, Ambala, Karnal, Panipat, Hissar, Baivani, Rohtak, Nabha, Patiala, Ferozpore, Faridkot, Kalka, Kasauli, Simla, Jullunder, Kapurthala, and 50 other small cities. Recently the electric power has been extended to Delhi, Gurgaon, Palwal and Rewari. The power will also be used for tube-well irrigation and for railway electrification especially on the main line between Delhi and Amritsar.

The three power houses at Bhakra, Ganguwal, and Kotla have a combined installed capacity of 604 m. w. and a total firm capacity of 337 m. w.

In 1964-65, an area of about 13.02 lakh hectares was irrigated by Bhakra canal system in the Punjab and Rajasthan. The canal system commands a gross area of about 27.4 lakh hectares.

3. *The Hirakud Project.* In Orissa it is the first of a chain of three dams planned for harnessing the waters of Mahanadi. At a point about 12 kilometers from Sambalpur, at Hirakud, the first dam will be constructed on the Mahanadi. This dam is to be 4.8 kilometers long, flanked by 2 dykes 69.6 kilometers long on the right and 9.6 kilometers long on the left. This dam will be 60 m. above river-bed. It will be the longest in the world and will form a 250 sq. miles lake with a storage capacity of 66 lakh acre-feet of water. The area covered by the dam and the dykes comes to about 35 kilo. There will be three flow-canals—2 from the left dyke and one from the right dyke. A power-house containing 4 units with the capacity of producing 123,000 kwh. has already been commissioned.

The second dam on this river will be at Tikkarpara and the third at Naraj. Later on dams will be constructed on the Ibb and Mand which are northern tributaries of Mahanadi; and on the Tel river which is its southern tributary.

This project is being executed by the Central Government on behalf of the Government of Orissa. The main dam and dykes have already been completed and irrigation facilities had been provided for 96792 hectares of land. The power-house has begun supplying power to a considerable extent.

Stage II of the project, estimated to cost Rs. 14.96 crores, has also been virtually completed with the installation and commissioning of three generating units of 24 m.w. each at the Chiplima power-house and two generating units of 37.5 m.w. each at the Hirakud power-house bringing the installed capacity of the former to 72 m.w., the latter to 198 m.w. and the overall total of the Hirakud Project to 270 m.w.

Power is being supplied to the cement factory at Rajgangpur, the steel works at Rourkela, the ferro-manganese plant at Joda, the paper mills at Brijrajnagar and textile and other industries in and around Chawdhar. The towns of Cuttack, Puri, Sambalpur, Sundergarh, Bargarh and several other places are getting power from Hirakud. The total installed capacity of the power-house at Hirakuhd is 1,23,000 kw.

4. *The Tungabhadra Project.* This project envisages a dam across the Tungabhadra river near Mallapuram, 4.8 kilometers above Hospet, in Bellary district. This project serves Mysore and Andhra Pradesh. This is a joint undertaking of the Governments of Mysore and Andhra. It comprises a dam 2413 metres long and 48 metres high. The dam was inaugurated in July, 1953. The reservoir, which has a water-spread of 292 sq. kilometers, will ultimately store 30-lakh acre-feet of water. The two canals on either side is nearly 203 km. long in Mysore and Andhra. There will be two power-stations on the Andhra-Mysore side one below the dam and the other at the end of a 15-mile canal at Babhasagaram. The stations with two generating units of 9,000 kw. each have been commissioned. A hydro-electric station constructed below the dam on the Andhra side also, with three

generators, of 9,000 kw. each have been installed in the first instance and another unit of 9000 kw. will be added shortly.

The project will cost about 45.1 crores of rupees. On completion nearly 33,5401.2 hectares of land will be irrigated and, in total, about 63,000 kw. of power will be generated.

5. *Kosi Project.* Kosi is one of the most furious rivers in India, which has been destroying the entire economic structure of the areas which became victims of its spate every year. Hence, for taming this river and protecting its valley from the floods a project was prepared in 1950 envisaging the construction of the project in seven stages at an estimated cost of Rs. 177 crores. This project is a multi-purpose project for irrigation, power, navigation, flood control, silt control, soil conservation, drainage, reclamation of water-logged areas, malaria control, fish culture and recreation facilities.

The construction of the embankments was started in 1955. This project will comprise a dam about 230 metres high across the Chatra Gorge in Nepal to store about 11 million acre-feet of water. There will be two barrages on the Kosi: (i) the first one in Nepal at Hanuman Nagar to control and stabilise the river channel and will divert its supplies into two canals on either side of the river. About a million acres will be irrigated by these two canals in Nepal, (ii) the second barrage will be near Nepal-Bihar border, where two canals on the left and one on the right will be constructed for irrigating over .8 hectares in the districts of Purnea, Darbhanga and Muzaffarpur in Bihar. Eastern Kosi Canal will take off from Hanuman Nagar Barrage. It will have branches—Murliganj Branch, Jankinagar Branch, Banmankhi Branch and Araria Branch.

On its completion, irrigation facilities will be provided to nearly 5.2 lakh hectares. The greater advantage that is being envisaged from this project is that about 75,000 cusecs of flood water would be diverted into old water-bed thus preventing the floods and protecting nearly 4000 sq. kilometres of land. The power plant at the dam site will be capable of generating 1.8 million kw. of power. It was expected to be completed by 1965 and estimate dto cost Rs. 68 crores.

Flood embankments protecting nearly 20720 sq. kms., in Nepal and India were completed in 1959.

A power station with an installed capacity of 20,000 kw. comprising four generating units of 5,000 kw. each, on the eastern Kosi Canal along with connected transmission lines at an estimated cost of Rs. 2.79 crores is under construction.

6. *Rihand Dam Project.* The work though contemplated as early as December, 1947 was actually started only after October, 1951. The project comprises of a concrete gravity dam across the Rihand river at Pipri which is 992 metres long and 91.5 metres high with a storage capacity of about 86 lakh acre-feet of water.

The power house at the foot of the dam has six generating units of 5 m.w. each. A net work of 132 kw. and 66 kw. transmission lines with the necessary sub-stations covers the entire eastern and South-eastern parts of Uttar Pradesh. Power is being supplied for use by cottage, medium and major industries and for irrigation pumping. The Rihand power supply in bulk has now spread over a fairly wide

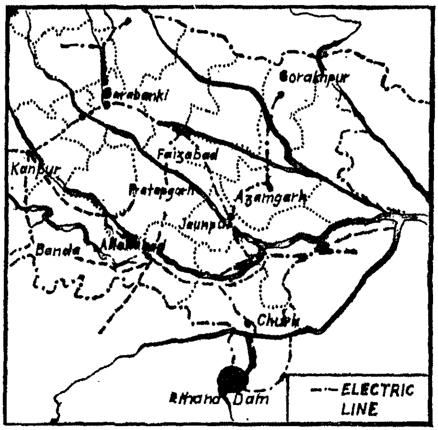


Fig. 47. Rihand gsid system.

area. The important industries directly served by the Rihand power are : Aluminium, Cement, Caustic Soda, Chlorine, paper, fertilizers, plastics and textile. The Rihand Service Area comprises of Mirzapur, Varanasi, Ghazipur, Ballia, Azamgarh, Jaunpur, Allahabad, Pratapgarh, Sultanpur, Faizabad, Basti, Gorakhpur, Banda, Fatehpur, Raibareli, Kanpur, Unao, Lucknow and certain districts of Bihar and Madhya Pradesh. Fig. 47 shows the transmission lines of Rihand power Supply.

The plant capacity at Rihand has been designed to enable the station to lend maximum support to the inter connected Hydro Thermal U.P. Grid. During off peak periods of power consumption, and periods of high flow through canal power stations in the state, water will be conserved in the Rihand reservoir, to be utilized to maximum advantage during peak load and dry-weather periods, thus serving the twin purposes of ensuring maximum load carrying capacity and overall economy for the entire system. Rihand power station alone would in this manner, contribute an affective capacity of 250,000 kw. to the state Grid, that of the combined Rihand-Obra group being about 350,000 kw.

7. *The Machkund project* is a joint scheme of Andhra and Orissa. This hydro-electric scheme harnesses the waters of the river Machkund on the boundary between the two states. A 53.5 metres high and 410 metres long storage dam has been constructed at Jalalpur on Machkund

river to store 625 000 acre-feet of water. The site of the power-house is at Duduma Falls about 200 kilometers from Vishakhapatnam by road. Three generating units, each with a capacity of 17,000 kw. are already operating. Later on three more units will be installed and the total power output brought to 212,000 kw. The total installed capacity of the power station is now 1,14,750 kw. The Project will cost about Rs. 13.60 crores for generation only. One set was formally commissioned by the President in August 1965.

8. *Kakrapara Project.* It may be regarded as the first phase of the development of the Tapti Valley. The construction of a weir 621 metres long and 14 metres high, on the rocky river bed near Kakrapara across R. Tapti 80 km. upstream of Surat was completed in June, 1953. It has two canals, one on each side. The scheme is expected to irrigate about 2.27 lakh hectares in Surat district and is expected to generate about 48,000 kw. of power.

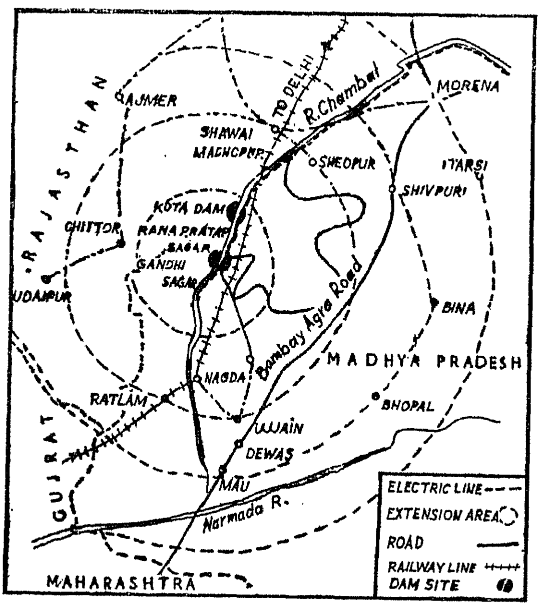


Fig. 48. Transmission lines of Chambal project.

9. *Mayurakshi Project* undertaken by the West Bengal Government is mainly an irrigation project, though it also provides for the installation of a 4 000 kw. hydro-electric plant. The power will be supplied to Birbhum and Murshidabad districts in West Bengal and Santhal Parganas in Bihar. The first stage of the Project was completed in 1951

with the construction of diversion barrage at Tilpara near Suri in Bengal. The 155 ft. high and 2,170 ft. long *Massanjore Dam* was completed in June 1955. The canals on either side will irrigate 6.5 lakh acres of land. A storage dam proposed for the Mayurakshi will have a capacity of 5-lakh acre—feet of water and will provide *rabi* irrigation to nearly 2000 hectares. The first 2,000 kw. generating set was commissioned in December, 1956 and the second in Feburary 1957.

10. *The Chambal Project.* Chambal is the largest river in M.P. and Rajasthan having its origin in the Vindhya range and falling into the Yamuna after flowing for over 960 kilo. The river has a fall of about 690 meters. The river flows over rocky surface and its banks are 1 to 91 m. high. The river is 761 metres wide but at Chawrasigarh the gorge narrows down to a mere 182 m. This river has a total drainage area of 110,000 sq. kms. The dam sites have been selected at 3 places —below Chawrasigarh fort, above Chulia falls and above Kota city— for power development and for irrigation a barrage 690 metres long will be constructed. About two canals will be dug from above the barrage, one on the left side towards Bundi and the other on the right side through Kota to M.P. 9 km. downstream of Kotah, with canals commanding over a million acres of land and will produce about 4 lakh tons of foodgrains. Fig. 48 shows the transmission lines of Chambal Project.

The first dam named after Mahatma Gandhi is being constructed near Chawrasigarh. The Gandhi Sagar Dam is 530 metres long and 60 m. high above the bed of the river. It will hold about 68.5 lakh acre-feet of water. The surafce area of the lake would measure 450 kilometres.

The Gandhi Sagar Dam and power station with four units have been completed and power generation was started from 19th day of November, 1960. The Kotah barrage has also been completed and water for irrigation was released on 20th November, 1960.

The second dam above the Chulia falls has been named the Rana Pratap Sagar Dam and the associated power project (the Bhupal Power Project). This dam will be 1006 metres long, and 30 m. high above the average river bed. It will submerge about 120 sq. kilometres and will impound about 1.40 million acre-feet of water. Water from this reservoir will be taken by means of two 15' diameter concrete conduits, 2961 metres long into a surge tank and thence through steel pen-stock pipes to the power-house about 4.8 km. above Bhainsrodgarh. On completion, it will produce 90,000 kw.

The third dam will be known as Kotah Dam and will be built in the river gorge about 16 kilometres north of Kota city. It will be 45 m. high, 25 m. wide and 547 m. long. It will generate 50,000 kw. of power.

The whole project will cost about Rs. 50 crores in all, out of which Rs. 40 crores will be shared by the Central Government and Rs. 5 crores each by Madhya Pradesh and Rajasthan Governments. It will provide water to over a million acres of land and produce 4 lakh tons of food-grains besides supplying an ultimate capacity of 2 lakh kw. of power. This power will be supplied to Sambhar Salt Lakes, marble mines of Makrana, soap-stone mines of Jaipur and, Bhilwara, and to Zawar mines and cement factory of Lakheri and to cotton textile and mills of Kota, Kishangarh, Bhilwara and Jaipur.

Pathratu Thermal Power Station. It is purely a thermal project and situated 5.4 km. from Pathratu railway station and about 40 kilometres from Ramgarh in Hazaribagh district of Bihar. In the first stage this power station will have an installed capacity of 400 mw. comprising four units of 50 mw. each and two units of 100 mw. each. The first 50 mw. unit has been commissioned and the remaining works will be completed by 1967-68.

Barauni Thermal Power Station. To meet the growing power demand in north Bihar, installation of a steam power station of 30 mw. capacity was sanctioned under the Second Plan. The project involving an aggregate installed capacity of 45 mw. has been completed.

Talcher Thermal Station. The scheme envisages the construction of a thermal power station comprising of four generating units of 62.5 mw. each at Talchar, where abundant reserves of low grade coal are available.

Bandel Thermal Station. This power station is located about 46 km. north of Calcutta close to the river Hooghly, by the side of Bandel-Barharwa railway line and at the centre of a rapidly growing industrial area.

Srisailam Hydro-electric Project. The Srisailam project envisages the construction of 117.5 metre high and 514 metre long stone masonry dam across the Krishna river, about 105.4 km. upstream of Nagarjuna-sagar dam site.

Satpura Thermal Power Station. This is a joint project of Rajasthan and Madhya Pradesh governments and is being executed to meet the anticipated load demand in the areas of western Madhya Pradesh and Rajasthan served by the Chambal grid system. It will be a thermal station in the Patherkheda Coal fields, in Betul district where five generating units each 62.5 mw. are under installation.

Naharkatiya Thermal Project. The primary object of the Stage I is, of course, supplying power to the Namrup fertilizer factory which has been completed. The power station utilises natural gas available from the Naharkatiya oil fields as fuel. Stage II involves installation of two more similar units (23 mw. each) and will be implemented during the Fourth Plan.

Badarpur Thermal Power Station. A central thermal power station with three generating units of 100 mw. each has been approved for installation at Badarpur (Delhi) under the Fourth Plan. The power will be mainly thermal and intended to supply bulk power to Punjab, Uttar Pradesh and Delhi.

POWER IN M. P.

Madhya Pradesh is one of the richest states of the Indian Republic in mineral resources, and yet it is one of the most backward in Power Development. Nature has endowed it with both basic and key materials such as iron, coal, bauxite, manganese, *etc.* Coal is found in abundance. The coal deposits of the state occur in three areas : (1) The Pench-Kanhan Valley, approximately 100 miles to the north of Nagpur, (ii) the Wardha basin, about 100 miles to the south of Nagpur, and (iii) the Chirimiri region in the eastern part of the state. These are at present being worked. The coal deposits found in the vicinity of Nagpur and Kamptee are yet to be worked. The State has an assured rainfall. Its river systems—the Narbada, the Tapti, the Mahanadi, the Wardha, the Wainganga, the Indravati—offer opportunities for multi-purpose development yielding power and irrigation.

But the pre-condition of any developmental plan is the availability of cheap power. The harnessing of the state river system could no doubt form the major sources of power-generation, but it is essentially a long-term measure. Large outlay is involved necessitating building up in advance a large electrical load and efforts to utilise any surplus power that may be there. The load consists of textile mills, ginning and pressing of cotton, rice mills, oil mills, hydrogenation of oil industry, paper mills, cement mills, newsprint and paper mills, manganese mining, collieries, aluminium, and steel and other industries.

But so far the development of electric supply in the state has been very slow. Introduced first for public supply in 1902 the total installed capacity of public supply undertakings in Madhya Pradesh upto1938-39 was only 11,030 k.w. This was stepped up later for war purposes during the period 1939-1944. The present capacity is 26,485 kw. bulk of which is concentrated at Nagpur, Jabalpur and Katni. The state as a whole, however, still remains power-starved. The total capacity of private-owned electricity installation is 29,484 kw. making an overall availability of power in the state to the extent of 55,969 kw. only. There is still a big gap between the supply and the demand for power. This cannot continue without detriment to the economic and industrial progress of the state.

As an immediate measure, therefore, Government decided to develop thermal power scheme and in 1945 invited the eminent electrical engineer, Sir Henry Howard from Madras to formulate an appropriate plan. Some of his principal recommendations were as follows :—

(1) to divide the state into five power districts—Nagpur, Chanda, Akola, Jabalpur (northern) and Raipur. (2) A power system in each

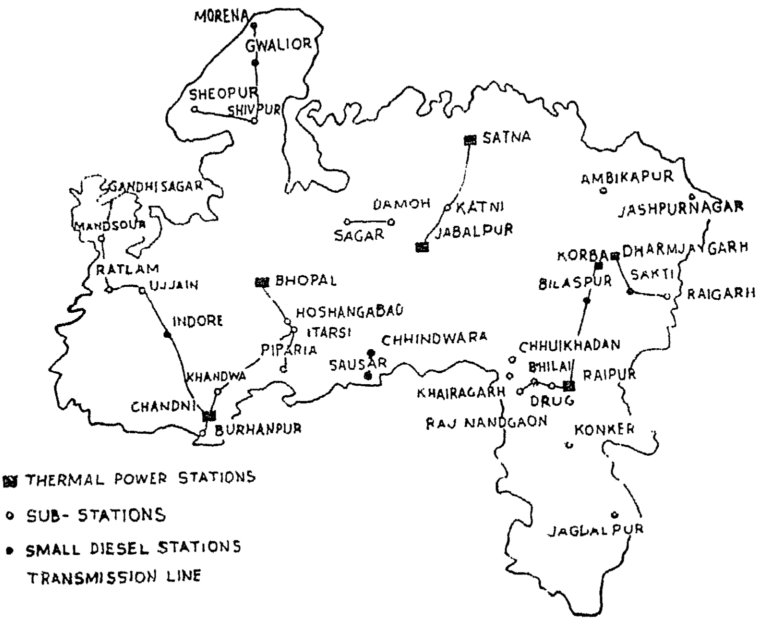


Fig. 49 Electric power in M. P.

district based in existing loads from suitably located thermal stations in each district. (3) These to be inter-connected at future date by trunk mains and neighbouring systems across the state border.

Accepting the recommendations in principle, the Government announced their decision in 1945 of establishing a central thermal electrical station near Nagpur with an installed capacity of 20,000 kw., capable of future expansion to 60,000 kw.

As a pre-requisite for such a development was evolved a five-year development plan ending in 1952 for providing the nucleus of a State electricity supply system to cover as wide an area as possible in the quickest possile time and ensure a reasonably cheap and abundant supply of electricity. For purposes of power development M.P. is divided into 3 grid systems—southern, northern, and eastern. They are at the moment independent, each fed by one or more central thermal stations, to be later inter-connected by provincial trunk mains, to the sources of water-power potential and to neighbouring systems at state borders. Work

is in progress on all these schemes. Places not reached by the nucleus grid will be developed by setting up small local thermal (diesel) generating stations and be later linked to the grid schemes. The aim here is to provide electricity to towns having a population of 10,000 and over, and to as many of major villages as possible, in course of time. Besides the Government have a scheme under consideration for intensive rural electrification in certain selected areas.

The Khaperkheda station forms part of the southern grid system. Situated on the right bank of the Kanhan river approximately four miles from Kamptee and ten miles from Nagpur, it has direct rail connection with the Pench Valley coal-fields in the north, and the Wardha basin in the south. Enough coal deposits exist in and around the site, working is not difficult and cost of coal will be cheap. Water in the river is plentiful and permits of enlarging the station to any reasonable degree. In such a set-up, the Khaperkheda station is designed to operate as a base. In planning the station the Government have also in view the growth of industries in the vicinity. They have, therefore, provided for a planned township.

With an operational capacity of 20,000 kw. the load expectation within the next few years from the power station is 42,900 kw. When it starts functioning, 16 new towns will, for the first time, begin to receive electricity; 11 out of the 16 electric supply companies in the areas served by the station will have stopped generation although continuing as distributing units; out of the 9 textile mills within its range, 4 with 12,000 kw. and approximately 1000 H.P. requirement will be changed over to the grid supply and all the 4 private generating stations in the coal-fields with an installed capacity of 3,200kw. and the new major mines not yet electrified requiring another 2 000 kw. (practically all the Pench fields and Wardha basin) will begin to be fed by this central station.

The station is expected to rationalise the power situation in the state. Together with the projected station in the Chanda-Ballarshah power district and the station at Chandni to which it will be inter-connected, Khaperkheda will make available an economical and widespread supply of electricity in the Nagpur and Berar divisions or in other words, the southern and western parts of the state. Power-feeders take off from the station in all the four directions—to Pench Valley in the north; to Akola, west Berar and Nimar in the west (in association with Chandni station); to Ballarshah in the south branching from Wardha; and to the manganese belt in the east which will in course of time extend to the Balaghat-Balhar plateau and the Bhandara district. The mining and textile industries and the electric supply companies have already taken advantage of it and are fast entering into contracts for supply from the Government grid. In fact, the entire capacity of the Khaperkheda station is already fully booked.

The towns that received electricity supply for the first time from the station are Ramtek, Tumsar, Bhandara, Kamptee-Kanhan, Warora, Wun, Ballarpur, Pulgaon, Dhamangaon, Badnera, Murtizapur, Achalpur, Saoner, Khapa, Sausar and Jamal-Parasia. An extension of the supply to the rural parts immediately in the Saoner Katol-Warud area is under active consideration. The Government grid scheme is intended to supply electricity by and by to all rural areas an a planned development in zones of 32 kilometres radius around each main substation location.

POWER DEVELOPMENT IN U. P.

At the beginning of the First Five Year Plan is 1950-51, the Electricity Department was supplying power in the Ganga Grid area and a few isolated places like Rampur, Faizabad and Azamgarh from local thermal stations. The Ganga Grid comprised seven hydel stations and two steam stations and six diesel stations with a total installed capacity of 40,700 kw. The total installed capacity of all the stations amounted to 47,349 kw. A major portion of the power generated was for feeding agricultural loads such as state tube wells, river pumping stations and agricultural industries. There were over 3,000 state tube wells, of which 2184 were in the Ganga Grid, 63 in Bareilly district, 20 in Basti, 20 in Deoria, 21 in Gorakhpur and others in the eastern districts of Uttar Pradesh.

During the First Plan period, several major works were taken up. Two hydel stations of Mohammadpur and Pathri were added to the Ganga Grid in 1951 and 1955, respectively, raising its installed capacity to 71,050 kw. and electrifying 485 more tube wells. Prior to the commissioning of the Pathri Station there was an acute shortage of power in the Grid with consequent restriction on sanctioning of load. From 1955, however, it became possible to sanction load in the Ganga Grid. Since then about 40,000 kw. fresh load, excluding pumping load, has been connected till March 1958.

EASTERN PROJECT

A project, known as the Eastern area power project and costing Rs. 677 lakhs, was prepared and approved by the Government in 1953 to bring power to the hitherto starved eastern districts of the State. Provision was made for electrification of about 1,250 state tube-wells and of major river pumping schemes, such as Tanda and Dohrighat pumping canals. The steam power stations, each of 15,000 kw. were envisaged at Gorakhpur, Sohwal and Mau. Construction of power stations and tube-wells was taken up side by side. In order to derive benefit from the completed tube-wells, the Government has constructed small power stations at various centres to feed the completed wells till such time as these big steam stations were completed. The following

seven small stations were, therefore, constructed in the eastern districts for the purpose : Gorakhpur steam station (3,125 kw.), Mau Steam station (1600 kw.), Deoria Diesel station (600 kw.), Mau diesel station (900 kw.), Sohwal diesel station (3,136 kw.) and Bhadohi (3,250 kw.).

The 15,000 kw. steam stations at Sohwal, Gorakhpur and Mau were commissioned in December 1957, after which these stations, except those of Bahraich and Bhadohi have been shut down. In the beginning the load on the interin stations was less than their capacity. However, in 1956 and 1957 the tube wells connected to the inter stations increased beyond their capacities and had to be run on a rostered basis. Rostering, however, was discontinued when the main steam stations were commissioned and there were ample power available to meet their demand. The Bahraich diesel station is still in operation.

The Agricultural districts of Mainpuri, Farrukhabad and Etah, adjacent to the Ganga Grid, were also in great need of power for irrigation development, with no spare power available in the Grid for the three districts, it was decided to construct a 10,000 kw. steam station at Mainpuri with a net work of lines to feed 343 state tube-wells and other loads in the area. Work on steam station began in 1954. It was commissioned in December 1957. The three internim diesel stations of Gursahaigunj (1,500 kw.), Nibkarori (2,750 kw.) and Mainpuri (750 kw.) in these districts were closed down.

The construction of the 41,400 kw. Sarda Hydel station presented foundation difficulties of such magnitude that it look ten years for the project to be completed. It was commissioned in April 1956. It is serving the ten districts of Nainital, Almora, Pilibhit, Bareilly, Shahjahanpur, Hardoi, Sitapur, Lakhimpur-Kheri, Barabanki and Lucknow. It is also feeding 500 state tube wells, several towns and other consumers, as well as licenses at Shahjahanpur, Lucknow, Bareilly, Pilibhit, Naini Tal *etc.*

To sum up the progress during the First Plan period , 17 power stations were added with an aggregate increase in installed capacity of 92,682 kw. 4,439 miles 7102.4 kilometres of transmission lines were constructed, 11 towns were electrified by the electricity department and supply was spread over 40 districts.

The Second Plan period originally included the following six new schemes: Harduaganj steam station (30,000 kw.). Yamuna Hydel Scheme Stage 1 (51,000 kw). Matatila Hydel Scheme (15,000 kw.). Electrification of 1500 State tube wells, rural and urban electrification and the Rihand Hydel Scheme.

The old Harduaganj steam station has a capacity of 15,000 kw. It is proposed to construct a steam station of 60,000 kw. near the existing

station for augmenting Ganga Grid generating capacity. The Yamuna Hydel Scheme was divided into two stages. Under Stage I, two Hydel stations of 17,000 kw. and 34,000 kw. respectively were constructed during the Second Plan period. Under Stage II, a Third hydel station of 1,50,000 kw. was constructed.

During 1958, the generating capacity of the four new steam power stations of Gorakhpur, Man, Sohawal and Mainpuri was developed to the full. The first three stations are feeding 1,200 tube-wells while the Manipuri station is serving 320 tube-wells. Besides, a large number of towns are being electrified and power is being given to start small industries. The power of Roorkee and Moradabad in Ganga Grid is utilized for domestic, industrial, irrigation and rural electrification purposes in the western and central districts of the State, including Garhwal.

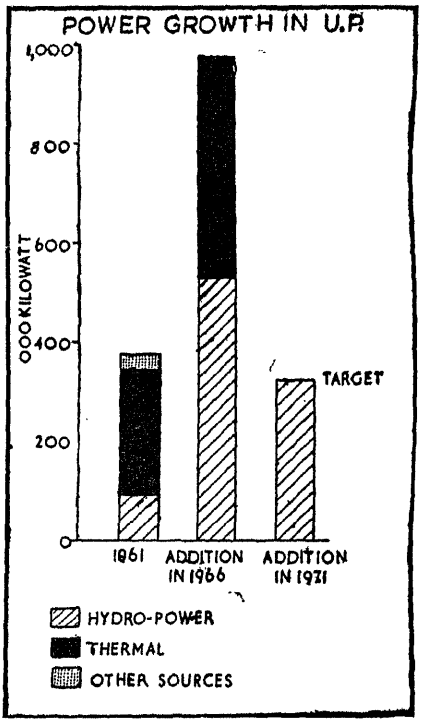


Fig. 50. Power Growth in U. P.

During the year 1958, 24 towns were electrified. They are : Rudauli and Baragaon in Bara Banki District, Kaiserganj in Bahraich, Rudrapur in Deoria, Jasrana in Etah, Akbarpur and Goshainganj in Faizabad, Fatehpur, Bindki and Khajuha in Fatehpur, Colonelganj, Uttraule and Mankapur in Gonda, Bhagwantnagar and Balamau in Hardoi, Mariahu in Jaunpur, Pukhrayan in Kanpur, Ramgarh in Nainital, Bilaspur in Rampur, Kadipur and Jaisinghpur in Sultanpur and Naya Bazar, Kadipur and Khamaria and Kachhwa Road in Varanasi districts.

During the year 402 state tube-wells were electrified all over the State. The number of sub-stations increased by 515 and the length of transmission lines by 2755.2 kilometres.

Central water and power commissions recent survey of the probable long-term growth of demand for electric power in Uttar Pradesh has indicated that the peak demands at the end of the Third, Fourth and Fifth Plan periods would be of the order of 805,000 kw., 1,430,000 kw. and 2,300,000 kw. respectively. Plant capacity would have to be considerably higher than these figures of peak demands, in order to meet unforeseen demands and provide reasonable maintenance and reserve capacity. These ever-increasing demands for electricity call for a very careful appraisal of all available resources and concerted action for timely implementation of schemes for their utilization. The figure 50 shows the Power Growth in Uttar Pradesh.

HYDRO-POWER POTENTIAL

On the Hydro side, the power potential of the State of Uttar Pradesh has been recently estimated at 3.764 million kw. at 60 per cent load factor. This is on the basis of 29 possible *prima facie*, economic schemes of power development in the Ganga Basin.

In addition to these there are major sources of hydro-power in Nepal which lie just beyond the boundaries of Uttar Pradesh and within easy reach of the main centres of power consumption in the State. Karnali basin alone has an estimated power potential of about 2.7 million kw. from which about 770,000 kw. can be generated from run-of-the-river stations, the balance from storage schemes. In view of the fact that for some time to come the demands for power in Nepal would be small relative to these large potentials, it is entirely possible that these major sources of hydro potential could be developed for the mutual advantage of Nepal and India.

Uttar Pradesh has, therefore, a very large store house of hydel power. It is particularly interesting that they are distributed fairly evenly along the northern and southern mountain ranges bordering the State, those in the Himalayan range being understandably larger. In

comparision to its vast resourcess, the present utilization represents barely 6 per cent of U.P.'s hydro-power potential, and a still smaller proportion of the total hydel resources available for utilization, including those of contiguous river basins in Nepal. These resources are more than enough to meet all the anticipated demands in the foreseeable future. In particular, the run-of-the-river schemes hold a great attraction, since they are inherently economical and can be implemented very quickly.

POWER DEVELOPMENT UNDER THE PLANS

The total river water resources in India were computed a few years ago at 1,356 million acre feet. Of this volume of water only 76 million acre-feet (5.6%) is at present being utilised for the purpose of irrigation and water-power generation and the remaining 94.4% runs to waste, causing untold damage before it enters the sea.

Water Resources of India

	Catchment Area sq. mile (000)	Norma Rain in inches	Mean Temp. F.	Loss (inches)	Run off (inches)	Run off (mil. Acre Ft.) Annual	Used for Irrigation (Mil. Acre Feet)
1. Rivers falling into Arabian Sea (Exc. Indus)	190	48	78	23	25	251	11
2. Indus Basin in India	136	22	55	13	9	64	11
3. Rivers falling in Bay of Bengal (Exc. Ganga and Brahmaputra)	467	42	79	29	13	334	23
4. Ganga System	377	44	62	24	20	397	26
5. Brahmaputra System	195	48	47	18	30	309	3
6. Rajasthan	65	11	79	11	..	..	..
	1430					1355	74

The position in regard to ultilization of water resources in the important river basins will be as set out below :—

River System	Estimated Average flow	Utilization up to 1951	Additional Utilization by Projects entered in I Plan	Additional Utilization by Projects entered in II Plan
Indus ..	168	8.0	11.0	1.2
Ganga ..	400	20.0	21.5	14.5
Brahmaputra	300	Nil	Nil	N l
Godavari ..	84	12.0	1.0	1.5
Mahanadi	84	0.6	10.5	0.2
Krishna ..	50	9.2	15.6	2.6
Narmada	32	0.2	Nil	10.1
Tapti ..	17	0.2	0.7	3.1
Cauvery ..	12	8.0	1.3	0.6

Attempts have been made to make assessment of the hydro-electric potential in the country. It has been estimated that the total hydro-electric potential, which it might be possible to develop from various sites, is about 35 million kw. This includes about 4 million kw. from the west flowing rivers, and about 7 million kw. from the east flowing rivers of the southern region, about four million kw. from the Narbada, Tapti, Mahanadi, Brahminini and Baitarni basins in the central region and about 20 million kw. from Ganga, Brahmaputra, Indus and other Himalayan rivers in the northern and north-eastern regions.

At the beginning of the First Plan, the total installed capacity of the power-generating plants amounted only to 2.3 million kw. At the end of the First Plan the aggregate installed generating capacity inereased by 1.1 million kw. or by 49%. By the end of the Second Plan there was an increase of 64% in the generating capacity which increased from 3.4 million kw. to 5.6 million kw. The Third Plan target of generating capacity has been fixed at 13.4 million kw. of which 12.7 million kw. will be in commercial operation. At the end of the Third Plan, per capita generation of electricity has been visualised to be about 95 kwh. whereas in 1951 it was 18 kwh.; in 1956, 28 kwh. and in 1961, 45 kwh. The cost of the power programme in the public sector in the Third Plan has been estimated to be Rs. 1,039 crores, and in the private sector Rs. ,0 crores.

The principal power schemes completed and brought into service during the First Plan are :—

Nangal (Punjab)	..	..	48,000	k.w.
Bokaro (Bihar)	..	..	150,000	„
Chola (Klayan, Bombay)	..	..	54,000	.

Khaperkheda (M.P.)	30,000	Kw
Moyar (Madras)	36,000	"
Madras City Plant Extensions (Madras) ..	30,000	"
Machkund (Andhra and Orissa) ..	34,000	"
Pathri (U.P.)	13,600	"
Sarda (U.P.)	27,600	"
Sengulam (Kerala)	48,300	"
Jog (Madras)	72,000	"

In addition, considerable progress has been made on a number of major projects which have been completed during the Second Plan.

In order to meet the demand of the new industries and the normal load growth and expansion of the existing power systems, it has been decided to raise the installed capacity in the country to 6.9 million kw. representing over a 100% increase in the generating capacity at the end of the First Plan—that is, there will be an additional generating capacity of 3.5 million kw. during the Second Plan. The power schemes for the Second Plan have been co-ordinated with regional requirements and available resources. Of the 44 new power schemes, 10 will cost over Rs. 10 crores each; 4 between Rs. 5 and Rs. 10 crores; 18 between Rs. 1 and 5 crores and 12 less than Rs. 1 crore, 25 are hydro-electric schemes, yielding about 2.2 million kw. and 19 thermal stations yielding 1.3 million kw.

In the Third Plan principal power generation schemes which are continuing are as follows :

Tungabhadra hydel project (stage II), Nellore thermal station, Panniar hydel project, Gandhisagar dam power station IV unit, Kundah hydel project, Koyna hydel project stage I, Purna hydel project, Tungabhadra left bank power—house, Hirakund hydel project, Bhakra-Nangal project, Rana Pratap Sagar dam power—house, Rihand hydel project, Matatila hydel project, Yamuna hydel project, Ramganga hydel, project, and Kosi project *etc.*

The principal new schemes which were undertaken in the Third Plan:

Nagarjuna Sagar hydel project (Andhra Pradesh), Srisailam hydel project (Andhra Pradesh), Umiam hydel project stage II (Assam), Kopili hydel project (Assam), Thermal extensions in D.V.C. area, Gandak hydel project (Bihar), Chenani hydel project (Jammu & Kashmir), Jhelum hydel project (Jammu & Kashmir), Tawa hydel project, Kundah hydel project, Periyar hydel project, Koyna project, stage II, Bhakra right bank power house, Beas project stage I, Kotah project and Gandhi Sugar V unit *etc.*

Broadly speaking, most of the electrical developments in India have so far been limited to satisfying the needs of the urban areas. This

has led to a lopsided development of our economy. It may be pointed out that 6 large cities—Bombay, Calcutta, Kanpur, Ahmedabad, Madras and Delhi-.account for 51% of the country's installed capacity and 54% of the generated energy. However, a few larger power systems serve the needs of rural areas also. Hitherto rural electrification has made head-way only in the Punjab, Madras, Mysore, Kerala and U.P. There has been a marked increase in the number of Towns and villages which are served with electric power, as will be clear from the following table :

Population Range	Total No. 1951 Census	Number electrified by March, 31			
		1951	1956	1961	1966
Over 1,00,000	73	49	73	73	73
50,000 to 1,00,000	111	88	111	111	111
10,000 to 50,000	1,257	500	716	1,176	1,257
below 10,000	5,59,665	3,050	6,500	25,410	41,559
Total	5,61,106	3,687	7,400	26,825	43,000

During the First Plan period, the actual number of electrified towns and villages with a population of less than 10,000 increased from 3050 in 1951, to 6500 in 1956 and 25470 in 1961. It is proposed to increase the number to 41559 in 1966 which makes it clear that in recent years there has been greater stress on rural electrification.

Developoment programme. The total installed generating capacity stood at 23 lakh kilowatts during the First Plan and there was an increase by 49% during the same period. During the IInd Plan the generating capacity rose from 34.2 lakh kw. to 56 lakh kw. *i.e.,* anincrease by 64%. By the end of the IIIrd Plan it is expected that total capacity of the plants in commission would be 134 lakh kilowatts and thus per capita generation of electricity would increase from 18 kwh. in 1957 to 95 kwh. in 1966.

The following table shows the growth of installed capacity and energy generated at the beginning and end of the First, Second and the Third Plan.

TABLE : *Power Generation Under the Plans*

	1950-51	1955-56	1960-61	1965-66
Installed Capacity (in lakh of kw.) Public utility undertakings				
(a) State owned	6	15	32	74.00
(b) Company owned	11	12	14	16.50
Self generating industrial establishments	6	7	10	11.50
Total	23	34	56	102.00

Energy generated (in crores of kwh.)				
Public Utility undertakings				
(a) State owned	210	457	1,102	3,45
(b) Company owned	300	402	592	
Self generating industrial establishments	147	219	319	390
Total	657	1,078	2,013	3,840

The principal power generating schemes of the Fourth Plan are given in Table CVI.

TABLE CVI: *Advance Action Scheme for the Fourth Plan*

Name of Scheme	Installed capacity M. W.
Kothagudam Stage I	120
Kothagudam Stage II	180
Lower Sileru Hydro	400
Gauhati Thermal Extension	30
Naharkatiyarmal Thermal Extension	46
Subarnrekha Hydro	120
Dhuvaran Extension	250
Chenani Extension	10
Diesel Sets	5
Ennore Thermal	330
Kodiar Hydro	100
Basin Bridge Extension	30
Kalpakkam Nuclear	400
Neyveli Extension	200
Nasik Thermal	280
Purli Thermal	60
Koyna Stage III	320
Bhatgar and Vir	23
Nagpur Thermal	480
Sharavath 9th and 10th units	178
Rana Pratap Sagar Nuclear Extension	200
Harduaganj Extension	240
Yamuna H. E. Stage IV	52
Dhukwan Hydro	22
Obra Extension	300
Santaldih Thermal	480
Durgapur VI Unit Extension	150
Badarpur Thermal	300
Gumti Hydro	11

NUCLEAR POWER

Having regard to the available energy resources, nuclear power is expected to play a progressively increasing part in meeting energy demands in future years.

Apsara, India's first reactor, incidentally the first reactor in Asia outside the U. S. S. R., attained criticality on Aug. 4, 1956. It was designed, engineered and built entirely by the engineers and scientists of the Trombay Establishment except for the fuel elements, which were provided by the United Kingdom Atomic Energy Authority under an agreement.

Apsara completed 11 years of operation on August 4, 1960 after operating for some 2.2 million kw. hours. In 1957 it operated for 17,800 kwh., in 1958 for 1,59,500 kwh. and in 1959 for 6,62,200kwh. During 1960, the reactor operated for 13,36 800 kwh. upto Aug. 20, 1960 when it was shut down for maintenance. The reactor is again in operation.

The Canada-India Reactor (C.I.R.) is India's second reactor, being a joint Indo-Canadian project under the Colombo Plan. It is a natural Uranium-filled, heavy water moderated and light water cooled high flux research reactor with a thermal power of 40 M.W. The reactor is mostly used for scientific, technological operations and for the production of large quantities of radioisotopes *etc.*

Zerlina is India's Third reactor. Zerlina, a zero energy reactor for lattice investigations and new assemblies reached criticality in January 1961.

A nuclear power station is planned for construction at Tarapur, near Bombay. It will consist of two reactors, each producing 190 mw. of power. The power station is expected to be commissioned by the end of 1968. A nuclear power station of the capacity of 200 mw. is also under construction at Rana Pratap Sagar in Rajasthan and is expected to be commissioned in 1969-70. Extension of the Rana Pratap Sagar nuclear station by 200 mw. and the establishment of the third nuclear station of 400 mw. capacity at Kalpakkam in Madras State have been sanctioned under the Fourth Plan.

Tidal power, wind power, geothermal power and solar radiations are other possible sources but their impact on electricity development in India has been insignificant so far.

Tidal and geo-thermal power plants have been in use only to a very limited extent. Research on direct conversion of solar energy into electricity is being carried out in many parts of the World. Wind power plants have been in use in India for pumping water in isolated locations. Recently the Council of Scientific and Industrial Research has set up a wind power division in the National Aero-nautical Laboratory in Ban-

galore for the purpose of making wind surveys and conducting pilot studies on a few wind mills and wind behaviour.

QUESTIONS

1. Discuss the development of hydel power in South India and show its influence on the industrial growth of the area. A.U. 1963.

2. "Irrigation is to agriculture what hydro-electricity is to industry". Discuss this statement with reference to Northern India. A.U. 1964.

3. Write an essay on the hydro-electric development of northern India.

4. Discuss briefly the geographical and economic factors that favour the development of hydro-electricity in the Indian Union. Name the chief centres of generation and the main use to which the power generated at these centres is put.

CHAPTER 20

A survey of India's mineral Resources

Minerals provide the means in tools and machinery for increasing the productivity of all persons whether engaged in producing goods, transporting materials or performing service. Today more than a hundred minerals go into manufacturing processes. Not all of them are of the same magnitude of importance. Some are basic to essential industries, some are vital for defence, others contribute to desirable but non-essential industries. Iron ore and coal are basic and both are used in large amount.

The standard of living of people is measured by their productiveness. If a society has to be highly productive, it must be well equipped with power-driven machinery, which means it must have abundant supplies of iron. In the East, manpower takes the place of the machine and the standard of living is set by the physical strength of the human muscles. At one end is the highly industrialized economy of the United States aiming at two cars in every garage (already it has one car to every three inhabitants), at the other an agricultural economy composed of hard manual labour and cramping poverty.

India is richly endowed in natural resources. In fact, her natural wealth is so extensive that Indians have been called a poor people living in a rich country. The mineral wealth of India as at present known, though by no means inexhaustible, comprises an adequate range of useful products that are necessary for the industrial development of the country. An appraisal of the reserves shows that while in respect of minerals essential for basic industries—coal and Iron—the reserves are ample, the country is deficient in a fairly long list of vital minerals like ores of copper, tin, lead, zinc, nickel, cobalt and in Sulphur and most important of all, petroleum. The position with regard to aluminium ore refractories, abrasives, limestones *etc.*, may be considered as fairly adequate while in respect of titanium and thorium ores and of mica, the country has considerable reserves.

Until recently, mineral exploration and their utilization in the country received little attention. Except for coal, iron ore and petroleum required for internal use, the majority of minerals were raised in India for purposes of bulk export without any dressing, processing and fabrication. These exports brought but a small return to the country.

Nearly a hundred minerals are known to be produced or worked in India of which nearly thirty may be considered more important including several which although comparatively unimportant in quantity today, are capable of material development in future with the expansion of industries. Her reserves of coal, iron and metals required for ferro-alloys are quite impressive as would be evidenced from the following table.

TABLE CVII : *Reserves of important Minerals in India.*

Minerals	Reserves in Million tons
Coal	66,000
Iron ore	21,000
Manganese ore	11,200
Illmenite	250
Bauxite	250
Chromite	13.2
Gypsum	74.0
Kyanite	57.5
Zinc and lead	10
Magnesite	100
Sillimanite	2.5
Monazite	25

The mineral resources are widely distributed all over the country. According to Dr. Dunn, "To west of a line drawn from Mangalore to Kanpur and to the Himalayas, mineral resources are not only sparsely distributed but are also perhaps unimportant with the exception of mica, lead, salt and some coal and perhaps copper in Rajasthan. Between individual states there is an unequal distribution of minerals." Dr. Wadia goes on to say that, "Nature has made a very unequal territorial distribution of minerals in the Indian region. The vast alluvial plain tract of North India is devoid of mines of economic minerals. The Archaean terrain of Bihar and Orissa possesses the largest concentration of ore deposits such as iron, manganese, copper, aluminium, chromium, valuable industrial minerals like mica, illmenite, phosphates and over three-fourths of India's reserves of coal, including coking coal. The iron-ore reserves lying in one or two districts of Bihar and adjoining territories of Orissa are calculated at over 8,000 million tons, surpassing in richness and extent those of any other known region. There are large, reserves of manganese ores, over 50% of World's best mica (Ruby mica), block splittings and sheet is supplied by the mica mines of Kodarma and Gaya in Bihar. The second minerally rich state is Madhya Pradesh carrying

good reserves of manganese, iron, limestone, coal and bauxite. Madras has workable deposits of iron, manganese, mica, limestone and lignite coal. Mysore has yielded all the gold of India, besides producing appreciable ores. Andhra has good reserves of second grade coal, besides being a potential source of several industrial minerals. Kerala possesses enormous concentrations of heavy mineral sands of high strategic importance, calculated to contain some 25 million tons of illemenite, besides containing monazite, zircon, rutile and garnet in workable quantities. Bombay (N.W. districts) now in Maharashtra, and East Punjab have been far less productive and have scarcely as yet figured in India's mineral statistics. Rajasthan, for a long time absent from India in mineral returns, is gradually becoming a productive centre, holding promise for bright figure in non-ferrous metals like copper, lead and zinc, mica, steatite, berrylium and precious stones like emerald and acquamarine, asbestos, lignite and gypsum, building stones, manganese. Assam supplies about 60 million gallons of much-needed petroleum, besides carrying important reserves of tertiary coal. Of the vast extent of the Himalayan region, the only proved mineralised regions of importance is the territory of Kashmir south of the Great Himalayan axis, with its coal (some of it is anthracite) aluminium ore, sapphire and some minor industrial minerals. But for the partly-known copper deposits of Sikkim and Kumaon and some fairly widely-spread iron ore bodies in these areas, the rest of the Himalayan region is a veritable *terancognita* as regards economic minerals. West Bengal's mineral resources are confined to coal and iron ores. Damodar valley area is very rich in mineral resources containing as it does the concentration of 100% of kyanite, 93% of iron ore, 80% of coal, 70% of chromite, 70% of mica, 50% of fire clay, 45% of asbestos, 45% of china clay, 20% of limestone, 10% of manganese and 10% of building materials."[1]

Classification of Mineral according to Industrial Value

Dr. D. N. Wadia [2] classified India's mineral resources into four divisions. These are—

1. Minerals in which India has large exportable surplus to dominate foreign markets such as

1. Iron ore	3. Tilanium and
2. Mica	4. Thorium ores

2. Minerals of which the exportable surplus forms an important part—

1. Manganese ore	5. Silica
2. Magnesite	6. Steatite

1 Dr. Wadia, D. N. —*Geological, and Goographic Distribution of India's Minerals*, 1949. London. Fourth Emp. Min. & Met. Cong., London.

2 Ibid. 1949.

3. Bauxite
4. Granite
7. Corundum
8. Monazite, *etc.*

3. Minerals in which India may be considered self-sufficient.

1. Coal
2. Cement materials
3. Aluminium ore
4. Copper ore
5. Chrome ore
6. Marble
7. Slate
8. Limestone
9. Dolomite
10. Gypsum
11. Borax
12. Zircon
13. Barytes
14. Antimony *etc.*

4. Minerals in which India depends mostly on foreign imports.

1. Silver
2. Nickel
3. Petroleum
4. Zinc
5. Lead
6. Tin
7. Mercury
8. Tungsten
9. Molybdenum
10. Platinum
11. Asphalt
12. Potash *etc.*

Production

The production figures for some important minearls are as follows :—

Year	Coal (million tons)	Iron (m. tons)	Mica (000 cwts.)	Manganese (000 tons)	chromite (000 tons)	Gold (kg.)	Copper (000 tons)	Bauxite (000 tons)
1951	34.4	3.6	200	1,692	16	7039	369	67
1952	36.3	3.9	152	1,462	35	7867	325	63
1953	35.9	3.8	128	1,902	68	6934	238	70
1954	36.8	4.3	103	1,413	45	7488	343	74
1955	38.2	4.6	465	1,584	89	6577	353	81
1956	39.4	4.8	561	1,687	52	6509	388	91
1957	42.0	5.0	609	1,568	78	5574	404	96
1958	46.0	—	—	—	—	5291	—	167
1959	47.8	—	—	—	—	5159	—	218
1960	52.6	110[4]	—	—	—	4994	—	—
1961	56.7	130	—	—	—	—	—	—
1962	638[3]	135	—	—	—	—	—	—
1963	663	148	—	1304	34969	4619	473	592
1964-65 June to Jan.	644	151	—	1473	59813	4062	463	703

3 Lakh Tons.
4 Lakh Tons.

The following table shows the mineral production in India during the years 1964 and 1965.

TABLE CVIII : *Quantity and Value of Minerals Produced* [5]

Value in thousand rupees

Mineral	Unit of quantity	1964 Quantity	1964 Value	1965 Quantity	1965 Value
Coal	'000 tons	6,24,40	1,50,95,01	66,670	1,68,52,18
Lignite	,,	15,69	36,428	2,331	56,783
Metallic Minerals Ferrous					
Chromite	tons	34,969	2,077	59,813	3,763
Iron ore	'000 tons	1,53,11	1,15,324	16,718	1,23,044
Manganese ore	,,	13,04	72,497	1,473	76,434
Non-Ferrous					
Bauxite	'000 tons	592	6,211	703	6,783
Copper ore	,,	473	24,121	468	24,715
Illmenite	tons	12	336	31	646
Lead	,,	6,130	3,985	5,582	3,629
Gold	kg.	4,619	5,63,67	4,062	4,96,51
Rutile	tons	1871	1841	1309	12,88
Silver	kg.	4735	1190	5355	1474
Zinc	tons	10,744	4660	9706	4209
Non-Metallic Minerals					
Apatite	tons	4090	143	4169	165
Corundum	,,	.540	303	429	242
Diamond	Carats	2260	1218	4136	1849
Dolomite	000 tons	521	6653	946	10785
Fireclay	,,	421	3407	400	3321
Gypsum	,,	883	6873	1148	8555
Kyanite	tons	34222	6291	34907	5493
Limestone	000 tons	17017	100331	19773	121597
Magnesite	,,	208	4096	235	4438
Mica (crude)	tons	22806	22545	22134	21952
Salt	000 tons	4647	86023	4996	78357
Sillimanite	tons	12362	942	11051	867
Steatite	'000 tons	134	3855	144	3822

5 Excludes the production from Goa

Figure 51 shows the minerals distribution in the Indian Union.

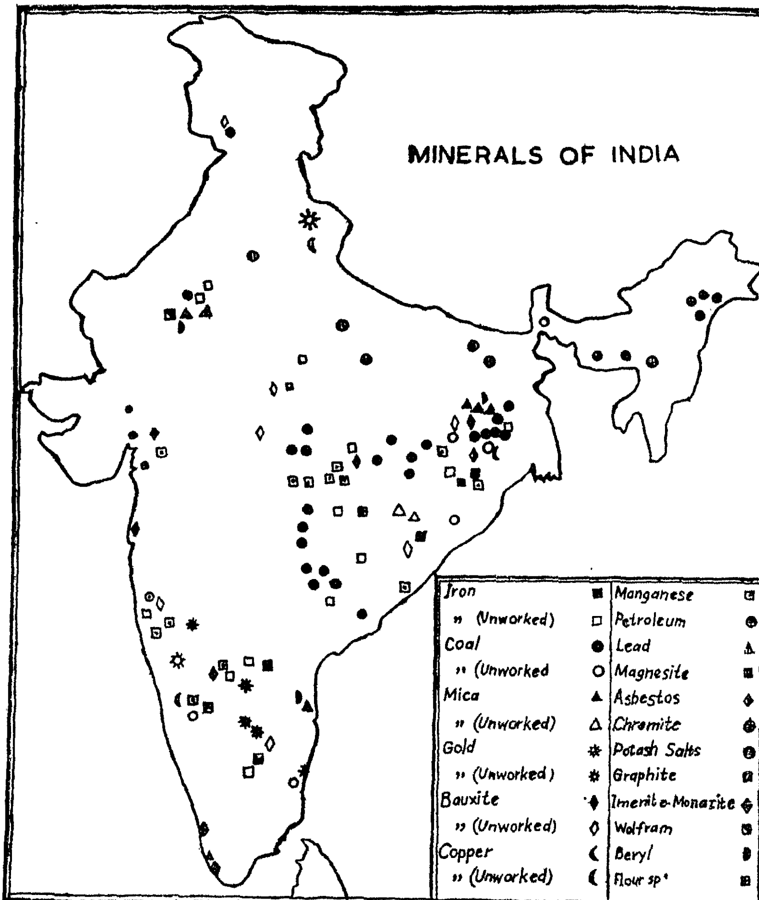


Fig. 51 Minerals of India

In the field of a number of minerals, we have been suffering from a chronic shortage for years, though most of the potential sources of such minerals within the country remained and indeed still remain, to be fully and properly investigated. This was particularly true of deposits of non-ferrous metallic ores; for instance, even with our proved large resources of high grade bauxite we have been importing large quantities of metallic aluminium for years. Known deposits of ores of copper, lead, zinc, magnesium *etc.*, have remained either practically uninves-

tigated or only partly developed, while our increasing annual demands have been met from extraneous sources.

In order to remedy this state of affairs, detailed prospecting for and proving of deposits of copper ores at Daribo and Khetri in Rajasthan, Almora and Tehri Garhwal in U.P., in Sikkim, in Singhbhum district in Bihar, Darjeeling and Jalpaiguri Districts of West Bengal and near Gani in Andhra are being taken up on behalf of the central Government by the Indian Bureau of Mines during the years 1958 to 64.

Similar measures are being taken in respect of the lead-zinc ores at Zewar in Rajasthan, Bolangir in Mayurbhanj, Orissa and Wasiri Rupi in the Kulu Valley; magnesite at Almora, bauxite in Orissa and Madhya Pradesh, in addition, during the same perriod similar investigations was carried out on known occurrences of illmenite, ores of tin, tungsten, manganese, chromium, gold and on occurrences of gypsum, asbestos, sillimanite, corundum, pyrite, graphite and diamond.

Export Trade in Minerals

Minerals occupy a prominent place in India's foreign trade. The export of manganese ore, iron ore, mica, coal, magnesite and other minerals earns cosiderable sums of foreign exchange for the country. The following table shows the foreign exchange earned by Export during 1961 and 1962.

TABLE CIX: *Foreign Exchange Earned by Export During* 1961 *and* 1962.

Country	1961 (Rs. million)	1962
U. S. A.	44	49
Japan	141	134
U. K.	52	43
France	14	8
Czechoslovakia	58	52
Pakistan	26	31
W. Germany	21	15
Italy	19	14
Netherlands	12	5
Belgium	8	6
Burma	6	3
Poland	16	18
Yugoslavia	13	13
Others	41	56

The total value of the export of ores and minerals is of the order of Rs. 30 to Rs. 35 crores per year. A brief account of the export trade in the more important minerals is given below.

Dealing with manganese ore first, we find that the export of this commodity reached a high level in recent years in 1960-61 when nearly 586,125 tons were shipped valued at over Rs. 71,111,000. The U.S.A. was our most important customer, accounting for Rs. 17 crores foreign exchange. India is the biggest manganese ore producer in Asia and the Far East. She does not however enjoy a monopoly in this commodity. The set-back to exports in the year 1961 was mainly due to the decline in steel production in some importing countries, increase in the output of manganese ore in the U.S.A. and the entry of Russia into the market.

Mica is another important source of foreign exchange. The value of mica exports amounted to Rs. 103,148,000 in 1959-60 though in the next two years there was a steep fall to Rs. 56 lakh and Rs. 50 lakh respectively. Among our main customers for mica are the U.S.A. and the U.K.

In India a good deal of iron ore is consumed within the country though a considerable quantity is exported. Exports in 1959-60, 1960-61 and 63-64 amounted to 36,945,000 tons, 2,511,000 tons and 3,038,000 tons valued at Rs. 12,9397,000, Rs. 8,967,000 and 13,3652,000 respectively. Our main customers are Japan, West Germany, Czechoslovakia and Belgium.

The export of coal used to fetch us a respectable amount of foreign exchange till recently but in the last two years there has been a set-back. The quantity of coal exported by sea has fallen steadily from 2 million tons in 1952-53 to 1.17 million tons in 1953-54; and 1.16 million tons in 1954-55. The fall in coal exports in recent years is mainly due to the increasing production in foreign countries, conversion of ships for oil, difficulties of exchange and revival of pre-war contracts. The declining offtake by Japan, our most important customer, is particularly significant.

The following table shows the exports of ores and minerals from India during the year 1962 and 1963.

TABLE CX : *Exports of Ores and Minerals from India.*

Minerals	Unit of Quantity	1962 Quantity	Value '000	1963 Quantity	Value (Rs. 000)
Abrasives	Tons	5	6	—	—
Aluminium	,,	75318	6935	75236	2590
Asbestos (raw)	,,	7	42	3	1
Asbestos others	,,	5	30	—	12
Barytes	,,	5506	531	4806	564

Bentonite	tons	217	34	—	1231
Bort	"	—	—	9203	—
Chromite	"	16534	1872	20	4
Chalk (crude)	"	176	2	3	—
Ball Clay	"	27	31	70	—
Earth Clay	"	14	221	84	10
Fire clay	"	232	28028	195	17
China clay	"	789	4	—	12451
Coal	000 tons	1082	4	—	—
Coke	tons	25	25	—	15
Diamond	"	34	27	—	—
Emeralds	"	—	66	—	3
Feldspar (crude)	"	—	65	552	31
Feldspar (natural-gem variety)	"	1093	—	7	59
Fuller's Earth	"	—	15	1. —	—
Graphite	"	—	1753	7	2
Gravel	"	15	—	18562	530
Gypsum	"	60277	7417	—	—
Illmenite	"	101248	—	66442	4465
Titanium	"	3390	178233	—	—
Iron ore	'000 tons	36945	8967	3038	133662
Kyanite	tons	18	7	15169	3826
Lime	"	98091	757	3	476
Limestone	"	198620	29539	49075	11071
Manganese ore	"	466181	46593	78145	20494
Manganese ore (ferruginous)	"	124491	6725	101281	4567
Manganese ore (Peroxide)	"	1208	362	3806	724
Manganese ore (others)	"	4189	370	68	47
Total Manganese ore	" "	282689	83589	392313	36907
Magnesite (calcined)	"	26457	15380	14854	3068
Magnesite	"	5605	837	787	126
Total Magnesite	"	32062	16217	75641	3194
Marble	"	32	7	2	2
Mica (blocks)	"	8545	17	883	17212
Mica (Splittings)	"	187	37601	3823	22420
Mica (others)	"	20462	54205	61	21261
Total Mica	"	31188	91823	18067	45942
Ochre (yellow)	"	12	3	13	2
Precious and Semi-precious stones	"	—	812	—	550

S

gand (including Sround quartz)	tons	4012	218	60	1
alt	,,	112775	2330	137391	2493
Saltpetre	,,	46	77	10	16
Sillimanite	,,	4896	1570	2848	911
Steatite	,,	15665	2938	—	1732
Stone	,,	29	19	—	18
Tungsten ore	,,	2	11	942	—
Zinc	,,	10757	2481	—	1571
Others	,,	—	4520	6870	2806
Total			446872		261107

Imports

The value of imports of minerals during 1957 was Rs. 10.2 crores as against 9.7 crores in 1956. The total value of metals imported during 1957 was Rs. 19.43 crores. The following table shows the import of ores and minerals into India during the year 1962-63.

TABLE CXI : *Import of Ores and Minerals into India*

Mineral	Unit of Quantity	1962 Quantity	1962 Value (Rs. '000)	1963 Quantity	1963 Value (in '000)
Abrasives	Tons	2792	3774	1431	2117
Aluminium ores	,,	3634	1576	23	31
Antimony ore	,,	1398	2155	1146	1679
Apatite	,,	287609	24836	136371	11039
Other mineral phosphates	,,	112	21	2	4
Asbestos (raw)	,,	22376	23277	14966	14834
Asbestos others	,,	2	6	2	2
Total	,,	22378	23283	14968	14836
Asphalt	,,	392	240	277	168
Barytes (calcined)	,,	2	1	—	—
Barytes	,,	6	4	—	—
Total	,,	8	5	—	—
Bentonite	Tons	143	69	2	2
Borax	,,	4884	3550	2460	2410
Chalk (crude)	,,	—	9	—	6
Ball Clay	,,	1871	369	970	188
China clay	,,	1524	265	—	—
Fire clay	,,	5027	899	2865	552
Earth clay	,,	6694	1499	2476	569

Coal	,,	117	72	17	18
Coke	,,	92	63	28	17
Briquettes (of Coke Coal *etc.*)	,,	11006	2801	2446	527
Copper ore	,,	3076	848	102	27
Cryolite	,,	3230	3146	1815	1815
Diatomaceous Earth	,,	1377	1039	636	527
Diamonds (industrial crude)	,,	—	—	—	—
Diamonds (natural gem variety)	,,	—	—	—	—
Emeralds	,,	—	1418	—	748
Feldspar (crude)	,,	—	1333	—	500
Feldspar (natural)	,,	—	9665	—	3583
Flints	,,	4	6	—	
Fuller's Earth	,,	—	—	—	—
Fluorspar	,,	156	36	122	32
Gravel	,,	237	141	49	31
Graphite	,,	9375	1900	4073	910
Gypsum	,,	50	12	35	23
Iron Ore	,,	2242	550	700	513
Lead ore	,,	2161	746	28233	977
Lime	,,	242	66	113	35
Limestone	,,	62	106	3	10
Marble	,,	12	6	—	—

In this place, also, it will be interesting to note the values recorded for imported minerals and for products obtained directly from minerals, during the period 1962-63. These figures, exclusive of the values of Cutlery and hardware, machinery and millwork, railway plant and rolling stock, earthenware and porcelain, glass and glassware, jewellery and plate of gold and silver, paints and colours and alizarine and aniline dyes, are shows in table CXI.

In 1964, on daily average 6,67,425 persons were engaged in mining (including Coal mining) in 3196 working mines coming under the Mines Act, 1952. The more important mining centres are in Bihar, Orissa, West Bengal, Madhya Pradesh, Rajasthan, Mysore and Andhra Pradesh and the more extensively worked minerals are coal (820 collieries), mica (650 mines) manganese ore (359 mines) iron ore (261 mines), limestone (245 mines), Steatite (119 mines), China clay (104 mines), fireclay (82 mines), barytes (74 mines), gypsum (70 mines), dolomite (51 mines) and bauxite (49 mines).

The National Mineral Development Corporation Ltd., was set up in November, 1958, for the exploitation of minerals other than oil,

natural gas and coal. A new Government Company, the Bharat Aluminium Co. (P.) Ltd., was set up in November 1965 to take up implementation of two new aluminium projects—a 50,000 tons per annum integrated aluminium project in the Koyna area of Maharashtra (to be completed in two stages, the first of 25,000 tons ready by 1969) and a one lakh tons integrated aluminium project at Korba in Madhya Pradesh, for which negotiations are under way with Hungary and the U.S.S.R. in respect of technical and financial assistance.

Steps for Industrialization

So far India has been an exporter of raw materials naturally, the economic return is low. The acts of digging the ore and dressing it for shipment require only a small part of the labour force that is needed to bring the ore material through all the steps of processing and fabricating into consumer products. Thus when the raw materials of a nation are shipped outside the country to be processed elsewhere, they serve to give employment to a large labour force in the importing country and to enrich her economies. Further, the foreign exchange earned by raw material exports purchase only a limited quantity of finished import goods.

Unless India can develop the fundamentally important industries such as tool-making, the manufacture of industrial and agricultural machinery, transporting equipment and electrical machinery her outlook for employment opportunities and a rising standard of living appears to be doubtful.

QUESTIONS

1. Explain the importance of either mica or manganese ores to India and give an account of their geographical distribution, utilization and trade. A.U. 1959.

2. Discuss the distribution and production of Iron ore or mica in India. A.U. 1964.

3. Give a geographical distribution of manganese and mica ores in India. Discuss their present and future economic value to the country.

4. Describe the importance of manganese ore in the Republic of India. Locate the areas of production and give an idea of the amount produced within the last ten years. Agra, 1958.

5. Discuss the geographical distribution of mica and bauxite in India. A.U. 1967.

CHAPTER 21

Mineral Resources

Industrial development of a country largely based upon the availability of resources—both natural and human—in that country. Hence before an attempt is made to make a survey of our present and future potentialities in the industrial field, it would be better to make an appraisal of these resources in our country. In this chapater I shall make an appraisal of India's mineral resources—their distribution, availability and the extent of their present exploitation and possibilities of future development.

Ancient India knew a good deal about metals and was skilled in the use of metals even in ancient times, and we know in Vedic period, iron, copper, tin, gold and silver were mined.

India "has underground numerous viens of all sorts of metals, for it contains much gold and silver and copper and iron in no small quantity, and even tin and other metals which are employed in making articles of use and ornament as well as the implements and accoutrements of war."

The above is a description of India as it was known in the time of Megasthenes or nearly 300 years B.C. To many it may appear that it was a fanciful and fabulous India, very different from the country as it is now known to us.

Metallic ores occupy the basic position in the economic life of the modern world. There are numerous uses to which the ores are put, but their greatest use is in the manufacture of machinery without which the wheels of the world cannot go on. The ores are found associated with the oldest rocks of the world. Here in India the system of rocks named Dharwar is the most widely occurring of such rocks.

IRON

India's resources of iron ore are of large dimensions. Ores of good quality occur in Singhbhum district of Bihar, Bonai and Mayurbhanj in Orissa; Chanda, Durg and Bastar districts of Madhya Pradesh. Salem, Tiruchirapalli and Bellary districts of Madras, Ratnagiri district of Maharashtra and the adjoining area of Goa, and in the Kadur and other districts of Mysore.

---

1 *Ancient India*, by J. W. Mccrindler, p. 13.

Bihar, Orissa and Mysore are the only parts of India in which large quantities of iron-ore are mined. Elsewhere specially in Andhra and Madhya Pradesh small quantities are mined for use in indigenous iron works. The most important iron-ore area in India is situated about 240 to 320 kilometres to the west of Calcutta in Bihar and Orissa, and contains large and rich deposits of iron-ore. The iron ore in the districts of Singhbhum, Keonjhar, Bonai and Mayurbhanj, usually occurs at or near the tops of hills. Near Jamda in the south of the Singhbhum district and in parts of Keonjhar, however, it is often found at lower slopes and in some cases actually in the plains themselves.

The most important of these ranges of hills containing iron-ore is the one that starts near Kompilai in Bonai and continues for a distance of about 48 kilometres towards Goa. Running more or less parallel to this range, and possibly faulted from it, are other smaller ranges which contain good iron-ore. The main range rises some 460 m. above the plain and the ore averages over 60% of iron for practically the whole length of it. To the east and west of these hill ranges, there are more irregular patches of ore occupying the tops of hills. Practically the whole of the ore is haematite and as far as is known, no quantity of magnetic occurs there.

The minimum quantities of ore reserves averaging not less than 60% iron are estimated as follows :—

Singhbhum District	..	1,047 Million tons
Keonjhar	..	988 ,, ,,
Bonai	..	648 ,, ,,
Mayurbhanj	..	18 ,, ,,

According to latest estimates these figures have been revised and deposits amount to about 6,500 million tons with a possible reserve of another 21,000 million tons.

Grades of Iron Ores

The iron ores in India are of three major grades, Haematite, Magnetite, and Limonitic.

(i) The *Haematite ores* are at present worked in Singhbhum, Keonjhar and Mayurbhanj districts as well as in the Bababudan hills of Mysore. They are rich in iron (60 to 69 p.c.) and include massive, hard and compact ores as well as shaly and powdery type. The powdery type is not being utilized at present but the mining concerns were aware of their high quality. All the deposits now being worked are on top of hills and ridges.

(ii) The *Magnetite ores* of igneous origin are found in S. E. Singhbhum and the adjacent parts of Mayurbhanj. Our knowledge of these is not sufficiently detailed for an estimate of the reserves, but it is stated

that in one deposit at Kumardhubi about a million tons of ore are found at the surface. These magnetite ores are particularly interesting because of their titanium, vanadium and chromium content.

(iii) The *Ironstone shale* group of the Raniganj coal-field, forming a stratigraphic, unit between Barakar coal measures and the Raniganj coal measures, has a thickness of about 1,200 feet and stretches over a length of some 33 miles in an east-west direction. Sideritic iron-ore occurs in these shales as numerous thin bands. These ores used to be worked near Kulti for feeding the blast furnaces of the Bengal Iron Co. up to about 1913. In that year they were replaced by much richer ores of Singhbhum obtained from quarries developed into limonite near the surface.

In view of the fact that there are large reserves of excellent haematite available within short distances of the coal-fields, the ironstones of the Raniganj field are not likely to receive attention at present.

The sedimentary iron-ores in the Tertiary formations are found in several places in Assam, in Darjeeling, Naini Tal and Almora districts.

Large deposits of laterities occur in many parts of the country, particularly in Madhya Pradesh, Maharashtra and Madras. Since better grades of iron-ore are easily accessible in many parts of the country, the laterites are not receiving attention.

The most important iron-ore area is situated in Bihar and Orissa and contains rich deposits of iron-ore. The deposits occur in the districts of Singhbhum, Keonjhar, Bonai and Mayurbhanj.

In Singhbhum district the iron-ore is mined in Kolhan where the important places are Pansira Buru, Gua, Buda Buru and Noamundi all in the then Kolhan estate. Iron-ore occurs usually at or near the tops of hills, the most important being the range running from about 4 kilometres south-west of Gua to the Kolhan-Keonjhar boundary east of Navogaon, *i.e.*, a distance of about 16 kilometres. The range, which rises some 457 metres above the plain, is said also to continue into the Keonjhar and Bonai. Parallel to this range is another similar line of hills running from the Duargui stream, four kilometres east of Bada, to the Karo river South-east of Ghatkuri, a distance of about 12 kilometres. Here the iron ore was found to occupy the top of the ridge as before, the ore in the southern part being apparently as good and continuous as in the adjoining range. To the west a third range of hills runs from the Karo river, east of Salai, to the east of Chota Nagra. Here also iron ore is found at or near the top of the range, but it appears to be confined to patches, which, however, are of considerable importance.

The Kolhan hematites usually appear to contain about 64 percent of iron, with phosphorus ranging from 0.03 to 0.08, or, in some cases, to as high as 0.15. The Sulphur content is usually below 0.03. Tita-

nuim in very small quantities is also said to be found occasionally in the ore.

The Indian Iron & Steel Co. Ltd., with their works at Burnpur and Kulti and Tata Iron & Steel Co. Ltd., with their works at Jamshedpur, are the most important users of Indian iron-ore. The Indian Iron & Steel Co. Ltd., take their ore from the mines situated at Gua in Kolhan. A branch line of the Eastern Rly. carries all the ore from these mines.

The Tata Iron & Steel Co. also possesses rich ores in Kolhan and in Keonjhar. Keonjhar possesses two fields one in the Baiga Buru ridge and the other at the north-eastern part which is really a continuation of Noamandi mine of Singhbhum. But prior to 1926 when Noamandi iron mine in Kolhan was opened, practically the whole of the supplies of iron-ore for the Tata came from their deposits in Mayurbhanj, which are nearest to the site of the work and to which the Railway runs a branch line, about 89 kilometres in length.

The occurrence of valuable iron-ore deposits in Mayurbhanj was first noticed by P.N. Bose[2] who mentioned the following occurrences—

1. Bamanghati Sub-division—
   (a) Gurumaishini Hill, over an area of 16 square kilometres.
   (b) Near Bandgaon in Saranda-pir.
   (c) Sulaipat Badampahar range from Kondadera to Jaidhanposi, a distance of some 19 kilometres.
2. Panchpir Sub-division—
   At several places from Kamdabedi and Kantikna to Thakurmunda, a distance of 40 kilometres.
3. Mayurbhanj proper—
   Simlipahar range, and the Sub-montane tract to the east (Gurguria, Kendua and Baldia).

(1) The Gurumahisani hill mass, with its three prominent peaks and its numerous flanks and spurs, forms a conspicuous feature of the northern part of Mayurbhanj. On the north side, the lower slopes of the hill have now been worked out and practically no ore remains below a height of about 400 feet above the plain level, but south of the main peak the ore is still unworked down to the foot of the hill. The average iron content of the Gurumahisani ore is 63 p.c.

(2) The Okampad (Syaipat) ore deposit is situated just west of the Khorkai river. Sulaipat ore is richer than Gurumahisani ore : it has about 67% metal content. The main ore body occurs on the top of the hill.

(3) The last of three major deposits occupies the Badampahar peak (805 metres) in the Sulaipat-Badampahar range, 12 kilometres South west from Okampad. Here again, as at Okampad, as single great

2. *Rec. G.S.J.* Vol., XXXI, P. No. 868, 1904.

lens of ore, roughly figured to be 915 metres long by 150 metres broad, with many smaller outlines, occupies the crest of the range, masses of rich float extending for many hundreds metres downwards. The Badampahar ore deposit is neither so large nor so rich in iron as the ores

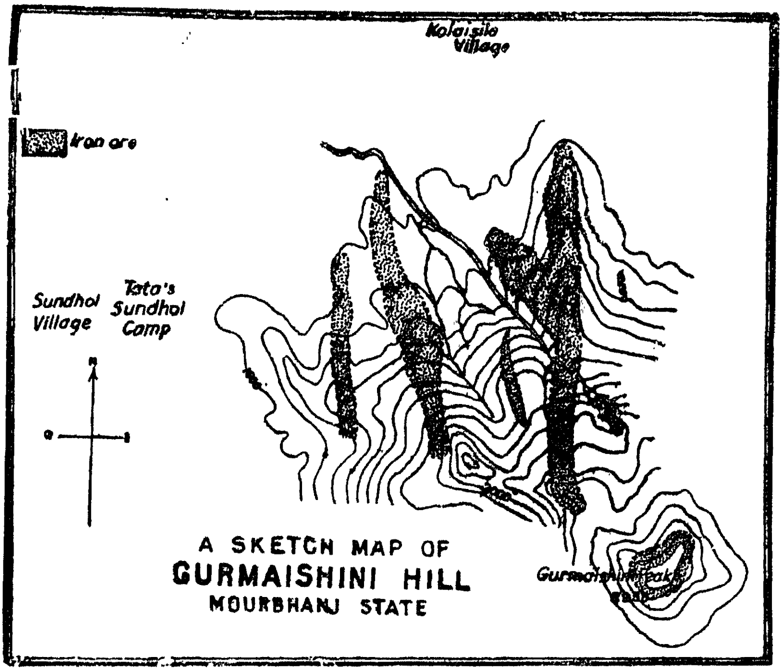


Fig. 52

of Sulaipat and Gurumahisani. It is, however, more porous and is highly valued on that account in spite of the lower iron content (56 to 58 p.c.).

The Tata Company's Noamundi Iron Mine is in Kolhan. The ore occurs in thick bedded deposits of haematite, averaging well over 60 p.c. iron. The ore is found on two main parallel ridges rising to a maximum height of about 305 metres above the railway level. The ore at the surface is either hard, massive or laminated. Below 30 metres in depth it appears to be largely powdery ore at quite shallow depths.

The Indian Iron Co. also draws its iron supplies now from Kolhan. The principal deposits are known as Pansira Buru and Buda Buru near Manharpur station of the E. Ry. The total quantity of the ore in Pansira Buru has been estimated at 10 million tons, that is, more than that of

Gurumahisani. whilst the estimates for Buda Buru are tremendous, about 150 million tons. The ore is generally a high grade haematite with an average content of 64 p. c. iron.

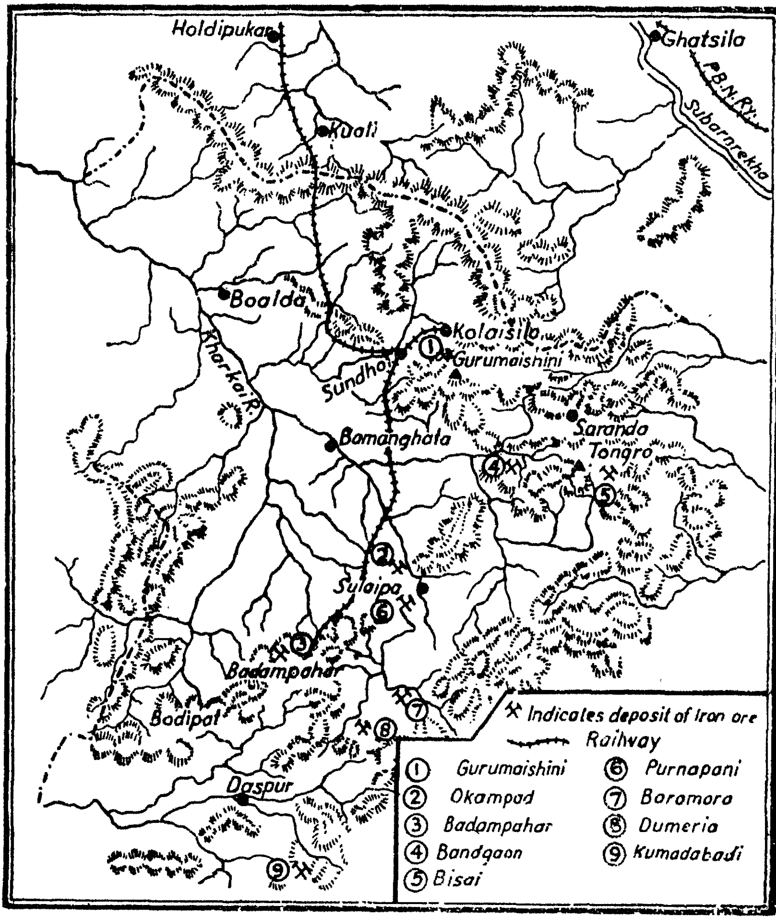


Fig. 53. Showing Important Iron Mines

Iron ore are known to occur in large quantities in the Mysore State and have been investigated by the Mysore Geological Department. According to Dr. W. F. Smith the ores appear to belong to various phases of the Archaean complex and to differ considerably in their modes of origin.

In Mysore, the haematite ores of the Bababudan hills are the most abundant and are of good quality, but they vary considerably in their

metal content and the amount of phosphorus they contain. The main source of the ore supply for the Bhadravati Iron Works of Mysore is the Kemmangundi ore-field, about 41 kilometres south of Bhadravati. The average analysis of the high-grade ore gives 64% iron, but medium and low-grade ores vary from 53 to 58 p.c. iron. The reserves are estimated at 25 to 60 million tons.

Rich ores occur in Madhya Pradesh and Madras, they are worked very little, being far away from coal. In the Drug district of Madhya Pradesh the ores, on account of their resistance to weathering agents, stand up as conspicuous hillocks in the general plain. The most remarkable is the ridge which includes the Dhali and Rajhara hills extending for about 32 kms. in a zigzag line, and rising to about 120 metre above the general level of the flat country around. In places thick masses of comparatively pure haematite are found. One such place is the Rajhara hill. It is estimated that about 7½ million tons of ore, carrying about 67.5 p.c. of iron are found here. The quantity estimated is for the ore that is visible on the surface. There may be more in the depths not yet proved.

In the Chanda district of Maharashtra the iron ore forms a hill three-eigths of a mile in length, 182 metre in breadth and 36 metre high. This hill is called the Lohara hill. The average Lohara ore contains 61 to 67 p.c. iron.

The iron ore of Goa and Ratnagiri localities is of Dharwarian age and crops out in the midst of laterite, is a hard ore composed either of limonite or of haematite containing minute crystals of magnetite. At Bicholim in Goa the principal ore band has beeh traced for a distance of 7kilometres and is said to vary in width from 30 to one hundred metres.

The ore found in Bellary (Mysore) and Kurnool, Cuddapah and Chittor districts (in Andhra Pradesh) is different in kind from the ore found in Orissa or M.P. This ore is magnetite. The principal occurrences are those of (1) Godamalai, (2) Thalamalai-Kolimalai, (3) Singapati, (4) Thirtamalai, and (5) Kanjamalai. The total quantity of ore here is considered to be 'practically inexhaustible.'[1] The scarcity of fuel, however, makes it impossible to work these ores on a large scale. The quantity of ore has been estimated at 304 million tons at Salem-Trichinopoly; 3 million tons at Kurnool and 130 million tons at Sandur.

Recently two large deposits of iron-ore containing an estimated reserve of nearly 389 million-tons of ore have been located in Andhra Pradesh. The deposits which are available in the Guntur and Nellore districts will last some centuries of the total deposits, nearly 296 million tons contain 33 to 37% of total iron in the stock. The remaining ore is of a lower grade with only 25 per cent.

1 Brochure on iron ores, Imperial Mineral Resources Bureau.

The Geological Survey of India have also discovered a new iron-ore field in the former PEPSU State now in Punjab. Here the iron belt stretches to a distance of 2½ miles running from Mahendragarh to Chappra, Antari and Biharipur in the north-south direction. This area is expected to contain 20 lakh tons of iron ore. The G.S.I. is also of the view that in Dhanora-Dhancholi area of Rajasthan the same quality of ore is expected to be available. Though this ore is suitable for steel making, yet it is not sufficient in quantity to run an Iron steel industry of a substantial size.

According to the recent investigations, of the iron-ore occurrences in parts of Guntur District, by the G.S.I. some valuable deposits of iron-ore are found in Andhra. In the Ongole group are included four deposits, namely, the Ongole beds, Konijedu-Marlapadu beds, Pernamitta beds and Sanampadi beds. The first three deposits lie in Ongole taluka (Guntur District) and thelast deposit lies in Kandukur taluka (Nellore District).

The reserves of iron ore estimated in the Ongole group are given as below :—

1.	Ongole beds	55,000 tons
2.	Konijedu-Marlapadu beds. (South of eastern portion)	27,87,84,000 ,,
3.	Pernamitta beds	1,28,90,000 ,,
4.	Sanampadi beds	9,90,000 ,,
	Total	29,21,79,000 tons

The magnetite quartz rock contains about 40 to 50 per cent silica and 33 to 37 per cent total iron-ore. The ore is not suitable for direct smelting but is amenable to benefication.

Other new finds have been located in Chabali in Andhra, Pagadalapalle, Rajampet, Pendlimarri and Mantapampalli (in Cuddaph district). The reserves of 30,000 tons have been estimated.

Production

The average annual production of iron ore during the past few years has been varying between two to three million tons, the chief producing regions being in the iron ore belt of Bihar, Orissa and Mysore. Mysore's share in production has been varying between 1000,000 to 1500,000 metric tons and practically all the rest has come from Bihar and Orissa. The contribution of Orissa to iron ore production ranges between 4000,000 metric tons to 4700,000 metric tons, and the rest comes practically from Bihar, Madhya Pradesh etc. The following table shows the production of iron ores in India.

TABLE CXII : *Production of Iron*

Orissa	4634000 Metric tons
Bihar	2919000 ,,
Madhya Pradesh	2304000 ,,
Mysore	1659000 ,,
Maharashtra	321000 ,,
Andhra Pradesh	209000 ,,

During 1962, Orissa, Bihar, Mysore and Madhya Pradesh accounted for 41%, 23%, 16% and 14%, while Andhra Pradesh, Maharashtra, Rajasthan and Punjab jointly accounted for the remaining 6% of the all Indian output. The following table shows the iron ore production after independence.

TABLE CXIII : *Production of Iron ore*

Year	Production (in thousand metric tons)
1947	2548
1950	3090
1953	3932
1955	4735
1958	5750
1959	8013
1960	10622
1961	10914
1962	2511000
1963	1922000
1964	15311000
1965	16718000

Reserves of iron ore

India has got good reserves of iron-ore in the world. From the qualitative point of view, with an iron content ranging up to 68% or more they occupy a very high position in the world. Apart from this high metal percentage, these ores are also notable for their lower sulphur content which never rises above 0.6 per cent. Both in quality and quantity these ores are regarded as superior even to the great American occurrences of Minnesota, Wisconsin and Michigan. The ores in the iron-belt of Bihar and Orissa are estimated to be sufficient for a thousand years with a pig iron output of 15 lakh tons annually.

The table, as under giving the estimated potential ore reserves in different countries, will be found interesting. It shows how the resources of India are considerable[1] :—

Country	Million Metric Tons	% of Iron content
Algeria	44	50
Brazil	10,807	55
Cuba	5,400	36
Canada	7,000	50
China	1,215	45
Fr. West Africa	2,600	47
France	3,876	37
India	10,272	51
Germany	840	30
Sweden	1,600	64
Spain	650	35
U. S. A.	25,488	36
U. K.	918	27
Venezuela	940	51

The ores in most cases contain a high percentage of metallic iron (over 60%) and are generally low in phosphorus and Sulphur. Reserves of good quality iron ore (containing over 60% iron) are estimated to be over 10,000 million tons, the bulk of which is concentrated in Bihar and Orissa.

According to Dr. Fox the reserves of different types of ore in India are as follows :—

Iron content	Reserve in m. tons
60%	3,341
45.6%	3,000
Less than 45.6%	1,500
Total ..	7,841 m. tons.

The following table shows the reserves of iron ore in India, having the metallic content of 60 per cent and over :—

1 U. N. O. World Iron ore resources, 1952.

TABLE CXIV : *Reserves of Iron ore*

State	Area	Approximate Reserves in lakh mln. tons	Total Reserves lakh mln. tons.
Haematite Ore			
1. Bihar and Orissa	Singhbhum, Keonjhar, Bonai, Sundargarh and Mayurbhanj	81600	27676
2. Madhya Pradesh	Thali, Dalli-Rajhara-Hills, Akola-Divalgaon Bailadila, Raoghat, Jabalpur, Lohara		15953
3. Maharashtra	Chanda Ratnagiri Gua	96600	424
4. Mysore	Dharwar, Bellary Chikmanglore, Chittal drug, Shimonga, Tumkur		9221
5. Andhra Pradesh	Kurnool, Adilabad Karemnagar, Nizamabad, Barangal		418
6. Kashmir			51
7. Rajasthan		306	51
8. Punjab	Patiala	300	20
9. U. P.	Hills		102
Magnetite Iron			
1. Madras	Salem, Tiruchirapalli	10200	3111
2. Andhra Pradesh	Guntur, Nellore	3966	3968
3. Mysore		5100	2193
4. Bihar		—	—
5. Orissa		—	51
6. Himachal Pradesh		612	612
Limonite Iron			
West Bengal		20400	5100
Total		219390	69255

Trade of iron

Export trade in Iron ore is of very recent origin. In 1949-50 all that we exported was 4000 tons of Iron ore to Japan valued at Rs. 1,23,000. Since then exports have been steadily rising from year to

year. In 1960 we exported 3,420,000 metric tons, in 1960 33,83,000 metric tons and in the nine month period of 1963 we have already exported 3038000 metric tons. Roughly speaking Japan takes 50% of our total exports. Although Japan produces iron ore she is one of the large importers. In 1953 they produced about 1,100,000 tons and imported 4,300,000 tons from various countries. Their imports of iron ore from India in that year were nearly 450,000 tons, *i.e.*, about 8.3% of their total requirements.

In 1960, our Iron ore output was 106,83,000 metric tons while the total world output was 191,400 thousand metric tons, *i.e.*, our output was about 1% of the total world output. We have almost unlimited supplies of iron ore. Production could be stepped up as required. Our competitors in the Japanese market for iron ore were Philippines, Canada, U. S. A., Malaya and Manchuria.

Iron ore is exported specially to Japan, U. S. A. and U. K. The following table gives the export figures :—

Export of Iron Ore

Year			Quantity (000 Tons)	Value (Lakh of Rs.)
1950-51	..	..	85	22
1951-52	..	..	280	100
1952-53	..	..	811	371
1953-54	..	..	1,262	579
1954-55	..	..	1,009	421
1955-56	..	..	1,363	627
1956-57	..	..	1,982	1,030
1957-58	..	..	2,216	1,186
1959-60	..	..	2510*	1,460
1960-61	..	..	3428*	1,700
				1,740
1961-62	..	..	3436*	179379
1962-63	..	..	3383*	178233
1963-64 Jan. to June		..	3038*	138662

Demand

The estimated demand for pig iron and steel is shown in the following table together with the present capacity and the schedule of expansion contemplated.

* 000 metric tons.

TABLE CXV : *Category wise break up of demand for Iron and Steel*
(000 tons)

End Product of Steel	1961	1965-66
Heavy rails and fishplates	325	400
Heavy structurals and broad flanged beams	445	550
Sleepers and crossing sleepers	180	200
Medium and light structurals	680	550
Rounds and flats including rounds for nuts, bolts	1305	2200
Tin plate	150	300
Plates $\frac{3}{16}''$ and up	300	650
Wire including wire ropes	220	400
Hoops and box strapping	45	50
Sheets	740	1200
Strips and Skelp for tubes	188	400
Forging blooms and billets	132	300
Wheels, tyres and axles	30	100
Total	4760	7300
Pig Iron for Sale	660-870	1500

MANGANESE

The Role of Manganese. Manganese, having so many remarkable qualities, has found wide application. Some of the applications are in special track layouts, points, crossing, etc. On railways wearing parts of rock crushers bucket lips of excavators and dredgers and many other items of mining equipment; wire line sheaves for oil well machinery; and many items in mechanical engineering.

Manganese in the form of alloys with iron and silicon is used in the manufacture of steel. In recent years a gradual reduction has taken place in the quantity of manganese consumed per ton of steel ingots. In 1949, the consumption in U. S. A. averaged 13.2 lb. of manganese per long ton of steel ingots.

Among non-ferrous alloys only the alloys of aluminium and copper have commercial importance. Copper maganese alloy is used for turbine blades with only 4% manganese. 'Manganin', of industrial importance when used as low-temperature co-efficient of electrical resistance, contains 8% to 12% manganese and 4% nickel. Manganese bronze contains 0.05% to 3.5% manganese besides the usual copper, zinc, iron, silicon, tin, nickel or aluminium. The commercial use of this alloy is for rolling into sheets for drawing into wires, for sand casting, for propellers of ships, and for mining machinery. The hardness of

aluminium increases when a little manganese is added to it. It also helps to resist more effectively corrosion by sea water. For sparking plugs, an alloy of 96% nickel and 4% manganese is used. Besides these there are various other alloys which contains manganese in small quantities.

Chemical (pyrolusite) is used principally for the manufacture of dry cells. It acts as a depolarizer. Ore used should contain much oxygen as in pyrolusite and very little iron, and be free from copper, nickel, cobalt, *etc.*, which are electronegative to zinc. A certain degree of porosity of the ore is also essential for providing a large-reaction surface.

Manganese oxide and other manganese compounds are added to act as driers to vegetable oils. The consumption of manganese compounds in this trade is appreciable. For use as pigments the following manganese carbonate, known as manganese white, Manganese oxide known as manganese green, manganese metaphosphate known as manganese violet, and pyrolusite known as manganese black. Manganese phosphate is used as a protective coating for steel. Manganese dioxide is used for news-print purposes.

Pyrolusite is used for the manufacture of iodine and chlorine, in the latter however it is now being replaced by the electrolytic process. As an oxidizing agent, manganese dioxide is used for certain chemicals, including hydroquinone.

Potassium permanganate has many chemical uses as an oxidizing agent sodium permanganate is used for refining nickel, and as a disinfectant.

Manganese Sulphate is used as a manure in combination with commercial fertilizers in alkaline soils. About 50 to 100 lb. per acre are required for the purpose.

Manganese chloride is used for dying cotton, manganese sulphate is used for calico printing, and ore of chemical grade is used in a small quantity for match industry. A mixture of manganese borate, linseed oil and resin is used for the leather industry.

India has fairly large deposits of manganese ore and is one of the chief producers : others are U.S.S.R., Brazil, South Africa and Gold Coast. Except U.S.S.R., none of the other great industrial countries possess manganese deposits of importance and deposits in India therefore assume special importance. The following table shows the production of Manganese ore in India in comparison with some other principal countries of the World.

TABLE CXVI : *Manganese Production*, 1963.

Countries	Production in short-tons
U. S. A.	10,622
Brazil	1320,000

Chile	51,235
Peru	1089
U. S. S. R.	7385,000
Yugoslavia	8964
Burma	220
China	1,100,000
India	1,184,983
Iran	1100
Japan	305,506
Malaya	7696
Thailand	7186
Turkey	6949
Angola	—
Congo Republic (formerly Belgian)	348,547
Ghana	434,410
Ivory Coast	153,291
Morocco	369,283
South African Republic	1,441,503
Australia	40,500

Our ores, which average 50 p.c. or more, are richer in manganese content than the Russian ores whose average is about 45%, Gold Coast, 41 to 50% and Brazil 23 to 50%. The prosperity of manganese mining is closely related to the production of steel, because the main use of the manganese-ore is in that industry. India is not a large producer of steel and the manganese miner in India, therefore, has to look to the steel producer of Europe or America. In 1958, the production of ore was estimated at 12,11,000 tons. Of this production Orissa contributed 355,000 tons, Maharashtra 306,000 tons, and Mysore 236,000 tons. In 1960 and 1961 the production of manganese-ore was 11,99,000 and 12,30,000 tons respectively.

Distribution of deposits

The chief manganese ore deposits are concentrated in a few regions, *viz.*, the districts of Chhindwara, Balaghat and Bhandara, Jhabua in M.P., Visakhapatnam in Andhra Pradesh, Bellary (Sandur) and Shimoga in Mysore, Panch Mahals and certain districts of Maharashtra and a few scattered areas in Bihar and Orissa. Of these, the largest and the richest are those of Madhya Pradesh yielding ores which are generally high in manganese content.

Madhya Pradesh. The typical ores of the Balaghat, Chhindwara area of Madhya Pradesh consist of mixtures of braunite and psilomelane

of different degrees of coarseness of grain. The most typical ore is a hard fine grained ore composed of these two minerals. The ores exported from Madhya Pradesh are nearly all of first grade, although at times of high prices, a small quantity of second-grade ore is exported. The chief characteristics of these ores are the high manganese contents (usually 49 to 54%), rather higher silica (usually about 6 to 9 percent, and largely due to the braunite in the ore), and moderately low phosphorus (about 0.07 to 0.17 percent).

The principal mining areas in Madhya Pradesh are as follows—

District Balaghat—Ukwa, Katgaria, Varwali, Netra, Ramrama, Batjari, Kochawahi, Salwa, Jam, Chikpara, Penniya, Tirodi, Mirangpur, Hatoli, Sukali etc.

In Chhindwara—Godavary, Warda, Butkum, Goti, Sitapur and Machiwana *etc.*

Maharashtra. Forming an integral portion of the same masses of rock as the Gonditic rocks of Madhya Pradesh, there are, at many places, bodies of manganese-ore often of large size and first rate quality, some of the manganese ore deposits of Maharashtra being the most valuable in India. The rocks of the Gondite series are supposed to have been formed by the metamorphism of a series of sediments deposited during Dharwar times. These sediments were partly mechanical (sands and clays) and partly chemical (manganese oxides). When these sediments were metamorphosed, the sands and clays were converted into quartzites, mica-phyllites and mica-Schists; the purest of the manganese oxide sediments were compacted into crystalline manganese-ores; whilst mixtures of the mechanical sediments, sand and clay, with the chemical sediments, manganese oxide, were converted into rocks composed of Manganese Silicates—spessartite and rhodonite-any silica left over, after accounting for the formation of these minerals, appearing as quartz. The rócks thus formed constitute the gondite series.

The ore bodies thus formed occur as lenticular masses and bands intercalated in the quartzite, schists and gneiss. The ore bodies are often well-bedded parallel to the strike of the enclosing rocks, and several of them are often disposed along the same line of strike, indicating that they have probably all been produced from the same bed of manganiferous sediment. A good example of such a line of deposits is in the Nagpur District of Maharashtra, stretching from Dumri Kalan to easterly direction as far as Khandala, a total distance of 19 kilometres, this line including the valuable deposits of Beldongri, Lohdongri, Kacharwahi and Waregeon.

The important ore producing centres in Nagpur District of Maharashtra are—

Salai, Bhandarkhori, Gondadoh, Manigaon, Bhandari, Chargaon, Parsoda, Satara, Sandari, Chorbabli, Junawati, Satak, Beldongri, Nagadhan, Lohardongri, Ramdogri, Gumgaon, Morgaon, Masar *etc.*

In Bhandara district the important ore producing centres are—

Dongri, Bujrum, Kurmura. Sita, Songi, Kargi, Asolpani, Jhangaria, Phitla. Nawgaon, The following table shows the Manganese production in Maharashtra.

Area	Production (0000 m. tons)
Bhandara	135.8
Nagpur	90.9
Panch Mahal	85.5

Bihar and Orissa. Manganese ore deposits are being worked near Sundargath, Korapat, Bolangiri, Keonjhar etc. Some 3.5 million tons of ore have been won in 1958. The following table shows the ore production in Bihar and Orissa.

Orissa—Manganese Production	(0000 million tons)
Keonjhar	288.9
Sundargarh	49.8
Korapat	13.8
Bolangiri	4.7

Bihar—Manganese Production

	Production Pig Ore	Casting Ore
Hazaribagh	16926	3769
Gaya	2350	167
Monghyr	614	52

Mysore State. The manganese ore deposits of Mysore are numerous, but very few of them can compare in size with those of Sandur Hills. The chief producing centres in Mysore state are—Kumisi, Shimoga, Bellary, Chitaldrug *etc.*

A large number of deposits, many of them of large size, have been located in the Sandur Hills, mostly perched upon the edge of the Hills at an average elevation of about 304 metres above the plains. The deposits are being worked here mainly from the Ramandrug and Kannevihalli areas.

Goa and Belgaum area. Manganese ores are sometimes found in true laterite, but such ores are rarely of much economic value. The ores of Goa occur in part in this way, as also those of Belgaum. They are not economically of great importance, owing to the irregular manner in which they occur, and their extremely variable composition.

Production

Mining of Manganese began in 1891 and developed rapidly during the early years of the present century. Annual production for the last

forty years has averaged about 600,000 tons and had exceeded the million ton mark in three years. Except for a small fraction of the total production consumed by the iron and steel projects, almost the entire production is exported in the raw form. The following table shows the production of manganese in India.

TABLE CVII : *Trend of Production*

1954	1,413,000 tons
1955	1,584,000 tons
1956	1,687,000 tons
1957	1,602,000 tons
1958	1,253,000 tons
1959	1,187 metric tons
1960	1,199 „ „
1961	1,230 „ „
1962	1,209 „ „
1964	1,360 „ „
1965	1,473 „ „

Consumption

Domestic consumption is mostly confined to the Steel industry which uses or for production of ferro-manganese required for steel plants. A certain amount of manganese ore is consumed in the glass industry and also in the manufacture of dry cells and in the chemical industry. Consumption of manganese ore in industries other than steel are not large.

Domestic consumption of manganese ore will go up during the next few years as a result of expansion envisaged in respect of iron and steel production and other industries. It is estimated that domestic requirements will go up to 100,000 tons by 1957-58. Later on, the Government of India was decided to double the production capacity. Out of this, 60,000 tons will be required for internal consumption and the rest will be available for export.

Reserves. The ore bearing region in Madhya Pradesh and Maharashtra extends over a length of more than 160 kilometres from Bhandara through Balaghat and Nagpur to Chhindwara district. The ore bodies are often of large size, but their extension in depth is not known. This lack of information is due to the comparatively small amount of underground mining that has been carried out and the almost complete a lack of drilling to determine the depth. The ores are hard and fine grained and usually high manganese content, which is over 49% in most of the ores from Bhandara and Balaghat districts. The phosphorus and iron contents are variable and the latter is usually high-rather too high for the

ore to be used straight in blast furnaces for high grade ferro-manganese production. The deposits in Sandur, Mysore and Gangpur, Keonjhar, Bonai, Kalahandi and Koraput areas in Orissa. The quality varies from high to low grade but they possess an advantage in their proximity to the iron and steel centres. Besides, these regions possess a certain amount of low phosphorus, low iron manganese ore and a certain quantity of ore rich in peroxide for use for chemical purposes.

The reserves of manganese are by far the largest in the world. The total is estimated at 1,000 million tons of ferro-grade ore and 200 million tons of ore of lower grade as will be clear from the following table :—

Known Manganese of the World

(in million short tons)

		High Grade (Average 45%)	Low Grade (Average 25%)
India	..	1,000	200
Union of S. Africa	..	50	..
French Morocco	..	30	20
Belgian Congo	..	10	20
Ghana (Gold Coast)	..	10	20
Brazil	..	50	..
Cuba	..	4	8
Other Areas	..	16	27

The figures of manganese reserves stand as under : Madhya Pradesh, 100,000,000 tons; Madras, Mysore 2,500,000 tons. Orissa, 100,000 tons and Bombay 5,000,000 tons.

The iron ores and the manganese ores are similar. There are some ores in which the proportion of manganese is considerable. These ores are called manganiferous iron-ores. The dividing line in between the manganiferous iron-ores and the manganese ores is now taken at 40 p.c. manganese content. In the U.S.A. this limit is at 35 p.c. only. Ores with less than 5 p.c. manganese content are called iron-ores.

India's proportion of world production of the manganese has varied from time to time owing to the appearance of new producers.

Export

Manganese ore is a traditional item of India's export trade. Even as far back as 1909-10 we exported 500,000 tons of this ore valued at Rs. 7027,000 (nearly Rs. 14 percent current price for high grade manganese ore is approximately Rs. 160 per ton). Until about 1951 annual exports of this ore have varied from 157,000 tons in 1944-45

to about a million tons in 1937-38. It was in 1951 that our exports of this ore began to shoot up. The all time high of 16,58,000 tons valued at Rs. 25,70,00000 was reached in 1953. In 1954 exports declined to a level of about one million tons and in 1955 the trend in the last few months is somewhat encouraging. Production of manganese ore in U.S.A. is insignificant compared to the total quantity consumed to the total quantity consumed by them. In the year 1953, U.S.A. imported about 1.1 million tons of Indian manganese ore *i.e.*, 40% of their total imports of about 2.8 million tons and the balance mainly from South Africa, the Gold Coast, Belgium Congo now Congo Republic and South American countries. The U.S.A. is by far the largest single buyer of our manganese ore. According to our current pattern of exports the U.S.A. takes about 40% of our manganese ore while Europe takes 30% and Japan and others the balance of 10%. In 1953 Russia is estimated to have produced 5 million tons which was about 50% of the total world output of 10.8 million tons, Indian output was the next highest with 1.6 million tons which was approximately 15% of the total world output. South Africa came third with 0.865 million tons, *i.e.*, about 8% of the total world output. South American countries produced about 7% of the World output. Russian manganese ore has recently come up in the World market after a long lapse of time. Brazilian output is rising. We have, therefore, to meet with very keen world competition. Partly by our geographical situation and partly on account of other reasons, ocean freight rates from India to U.S.A., Europe and Japan are against us. At the current prices of manganese ore and ocean freight rates, ocean freight constitutes more than 25% of the C.I.F. price. Our competitors in South America, South Africa, Russia *etc.*, are more favourably placed in this regard. However, with rising tempo of steel production in U.S.A. and elsewhere and by reason of our better grade ore we may still be able to maintain exports at the level of about 1.25 million tons a year (approximately Rs. 20 crores worth) or slightly Rs. 20 crores worth. The following table shows the exports of manganese since 1951.

TABLE CXVIII : *Exports of Manganese.*

Year		Exports (in 000 tons)
1954	..	1,092
1955	..	1,232
1956	..	1,458
1957	..	1,706
1958	..	976
1959	..	986 metric tons
1960	..	1,160 ,, ,,
1961	..	1,013 ,, ,,
1962	..	782 ,, ,,
1963	..	392 ,, ,,

Most of the exports go to Great Britain. Other countries taking our manganese-ore are France, Japan, Belgium and Germany. During 1961-62 we exported 1040 lakh rupees worth of manganese ore as against 1400 lakh in 1960-61 through Vishakhapatnam, Bombay and Calcutta ports.

There is a steady consumption of the manganese-ore at the works of the three principal iron and steel companies, not only for use in the steel furnaces and for the manufacture of ferro-manganese; but also for addition to the blast furnace charge in the manufacture of pig iron.

Manganese ore is a true "Jack of all-trades" among industrial materials. It is used in porcelain enamel, dry batteries, building brick, glazed pottery, plastics, colouring and decolouring glass, disinfectants, welding rod, chemicals, varnish and floor tile. The steel industry is, however, the largest consumer, taking more than 90 p. c. of the world output.

MICA

Mica is a group name for several minerals which, though differing in chemical composition and physical properties, are characterised by their ability to split readily into very thin plates or flakes which are more or less tough, elastic and transparent according to variety. Only the three following varieties are known commercially as mica :—

(1) Muscovite (white mica)

(2) Phlogopite (amber mica)

(3) Biotite (black mica)

Muscovite is the most important mica of commerce, phlogopite coming next to it, but biotite is practically of no value.

Distribution

The chief mica-mining areas in India are those of Hazaribagh in Bihar and Nellore in Andhra. Mica has also been obtained from workings in the Eranial taluk of Kerala, the Hassan district of Mysore and Ajmer and Udaipur districts in Rajasthan.

The 'Mica Belt' of Bihar obliquely traverses the districts of Gaya, Hazaribagh and Monghyr, along a strip about 19 kilo broad and over 96 kilometres long. A large number of the more important workings are situated either in or near Kodarma forest especically at Koderma, Domchanch, Giridin, Chakal, Dhaw etc. By far the larger proportion of the Indian output of mica is obtained from the Bihar Mica Belt, although the mica is often commercially spoken of as 'Bengal Mica'. All this mica is sent to Calcutta whence it is exported.

Bihar produces about 60% of the Indian output. The following table shows the mica production in Bihar during the year 1958.

Bihar Mica Production

Area	Production	
	Total Production Impure	Refined Mica
Gaya	2,350 metric tons	167 m. tons
Hazaribagh	16,926 ,,	3,767 ,,
Monghyr	614 ,,	52 ,,

Workable deposits of mica have been located in Orissa in the districts of Ganjam, Koraput, Cuttack and Sambalpur, in Rajasthan in Udaipur (Bhilwara, Shahpura, Tonk, Raipur, Rajnagar). Ajmer, Jaipur districts : in Punalur and Nayyoor in Kerala.

Mica both in Bihar and Andhra occurs in pegmatites. The pegmatite veins are generally lenticular in shape and many have a maximum length of 457 metres with a maximum thickness of 30 metre. Mica occurs in rough crystals called 'blocks' or books, those measuring 15 ft. in length and 10 ft. in thickness are kown to occur. It has been found that mica represents about 6% of the total rock excavated, while mica of saleable quality after dressing represents only 1 per cent. The value of mica depends upon the size of books, perfection of cleavage, colour and clearness.

The Deposits in Rajasthan occur in Ajmer, Mewar, Kishangarh, Jaipur and Tonk. Most of these deposits are still in an large stage of development and are likely to become more important when intensive prospecting and mining are undertaken. At present, Rajasthan is responsible for about 25% of the Indian production. Most of the production from Rajasthan is sent to Bihar to be split and marketed.

Mica deposits are found in Madras at several places, the most important being those of the Nellore district where there is a mica belt about 64 kilometres long and 8 to 16 kilometres wide. The greater portion of Madras production is of the variety known as "green" mica. Mica deposits also occur in Vishakhapatnam, west Godawari, Salem, Nilgiri, Madurai and Coimbatore districts and in the State of Kerala.

Mica is used in a large number of industries, in medicinal preparations and for decorative and ornamental purposes. It is now regarded as one of the chief strategic minerals. It enjoys certain special qualities like transparency, breakability into thin films, flexibility, elasticity and resistance to heat. Hence, it is used in making lamp chimneys, fronts of stoves, furnaces, protective spectacles, fire-proof points, patent roofing materials, in wireless telegraphy, radio communication, aeronautical engineering and motor transport. Ground mica is used as a lubricant.

However, the chief use of mica is for electrical purposes as an insulator. Formerly only larger sizes of mica were in use, but during the war smaller sizes also became marketable. This is largely due to the development of the micanite industry. Micanite is really the built-up sheets of the smallest and thinnest films of mica which are cemented together with shellac dissolved in spirit. The micanite sheets can be built to any size and thickness. They require to be steamed, pressed and rolled, and then can be moulded to any desired shape. India has practically a monopoly of mica and shellac used in making micanite. And yet micanite is not manufactured in India for want of industrial development, especially that of electrical industry.

Production

India produces about 70 to 80% of the world's supply of mica, about three-quarters coming from Hazaribagh and the rest from Nellore and Rajasthan. The best quality of mica comes from Bihar. The following table shows the state-wise production of mica in India.

Production of Mica in India

States		Production (metric tons)
Bihar	..	1,989
Rajasthan	..	6,362
Andhra Pradesh	..	5,198
Madras	..	262
Mysore	..	1
Kerala	..	98

The following table shows the trend of production in India since 1957.

TABLE CXIX: *Manganese Production*

Year		Production (metric tons)
1957	..	30,943
1958	..	31,942
1959	..	28,846
1960	..	28,182
1961	..	28,647
1962	..	..
1963	..	..
1964	..	28,806 tons
1965	..	22,134 tons

27

Trade

Most of the Mica is exported to foreign countries. It is an important earner of foreign exchange. The annual value of the mica exports during the last decade was of the order of Rs. 1½ to 3 crores. This has gone up during the last two years as a result of large purchases by the Government of U.S.A. for stock piling purposes. The quantity and value of mica exported from India are given below.

TABLE CXX : *Exports of Mica Products*

Year	Blocks in cwts.	Splittings	Total including (waste and scrap)
1948	14.9	174.8	255.2
1949	12.1	200.1	340.2
1950	8.8	207.5	297.7
1951	20.6	238.6	383.4
1952	..	..	..
1958	88.7	647.0	..
1963*	397.9	155.95	555.47

Practically the whole of the mica produced here is exported to Great Britain, United States, Germany and France.

The exports mainly go through Calcutta, Madras, Vishakhapatnam and Bombay. The following table gives the mica exports from India :—

1948-49	Valued at Rs.	593	lakhs
1950-51	,,	1,000	,,
1951-52	,,	1,321	,,
1952-53	,,	901	,,
1953-54	,,	800	,,
1954-55	,,	672	,,
1955-56	,,	837	,,
1959-60	,,	1,000	,,
1960-61	,,	1,020	,,
1961-62	,,	970	,,

The financial turnover of the mica industry is small compared to the major industries of India. It is concentrated in four or five districts in India, in Hazaribagh, Gaya and Monghyr in Bihar, in Nellore and in Rajasthan. In Bihar is concentrated the main source of *muscovite mica*, so indispensable for electrical, auto and aero industry and which is the only raw material which was carried by air from India at a cost of about Rs. 4,000 per maund during the First World War.

* Figures in thousand pounds.

The worker employed in mining and manufacturing of mica exceed over two lakhs all over India of which one lakh and a half are concentrated in Bihar alone. The quality of mica mined from Bihar as well as the unrivalled skill of the Bihar workers have placed the mica industry on a semi-monopolistic basis in the world. Although deposits in South Africa, Brazil, Canada and Russia have sought to undermine its position, yet predominance of the Indian mica industry is beyond question even now.

Reserves

On account of the irregular deposits of the mineral in the rock, it is not possible to indicate the size of the reserves of mica in any of the above mentioned regions. Most of the working are either open cast quarries or shallow mines and the deepest mica mines in Bihar and Madras are stated to be only about 182 metres deep. Juding by present indications, it can be safely stated that there are untapped reserves which will run for many decades at the present rate of production.

COPPER

Copper is largely used for electrical purposes, mechanical refrigrator, air-conditioning apparatus, cable, telephone, radio, telegraph, electric locomotive, water pipes and roofing material. Copper is also cast into bearing, bushing, lubricators, valves, and fittings; it is alloyed with iron and nickel in the production of Stainless Steel, with nickel to make "Morel metal", and with aluminium to make duralumin; and it enters into the manufacture of Steam radiators, clocks, watches, locks and many other things. It is also used in making coins.

Distribution

There are evidences of copper having been mined in India in the past over a very large part. In the Singhbhum district of Bihar a copper bearing belt, marked out by old workings, persists for about 144 kilometers, extending from Duarparam on the Bajhmini river in an easterly direction through Kharsawan and Saraikela into Dhalbhum, where it curves round to south-east, running through Rajdoha and Matigam to Bhairagota. The important portion of this belt ocours between Rajdah and Badia. The copper ores in India occur as indefinite lodes interbedded with other rocks. Sometimes the ore is collected into fairly well-defined bands, but very frequently it occurs in the form of grains so sparsely distributed through a considerable thickness of hard rocks as to be unworkable. When concentrated into definite lodes, as at Matigara or Mosaboni, the ore may be of high grade.

The most important copper works in India belong to the Indian Copper Corporation at Maubhandar, Ghatsila. This company con-

verts into brass sheets with the help of zinc any copper that it cannot sell as ingots in India.

Two parallel ore deposits have been developed in the Mosaboni mine. The grade of ore here varies from 2.5 to 3 p.c. of copper. There is also a little production of Dhobani where a deposit parallel to that at Mosaboni is being opened up. The proved resources of copper ore of Singhbhum district are estimated at 3.3 million tons. Here the ores are primarily chalcopyrite and secondary carbonates.

Other important regions where occurrence of copper ore has recently been reported are Sikkim, Garhwal, Rajasthan and Andhra Pradesh.

Best known deposit in Sikkim is Bhotang near Rangpo. At the Bhotang mine there is a load of 10′ to 15′ thick containing ore on an average tenor of 3 to 4 per cent copper. Here several other prospective regions occur, *e.g.*, Dikchu, Rohtak, Sirbong, Sisni, Jugdum, etc. At Dikchu the load is 1 metre in width and is traceable for 90 metres. It contains 6.14% of copper.

In U.P. in Garhwal district there are workings at Dhanpur and Pokhri but little information is available about the reserves as no prospecting has been done so far.

In Rajasthan copper minerals are found in irregular veins and stringers in highly deformed phylites in Khoh-Dariba area (in Alwar). This zone is roughly 180 metres in length, average width of 10 metre extending to a depth of 45 metres from surface. Here there are found extensive old workings. There is another mineralised zone of over 15 miles in length in Khetri area (in Jaipur), ore occurring in slates and schists.

In Andhra, there are two prospective areas. They are Agnigundal (14 kilometres north of Vinukon in Guntur Distt.), and Gani (in the Kurnool Distt.). No sytematic survey has yet been carried out so far.

Production

The production of copper—ore and refined copper in India is given in the following table :—

Year	Copper Ore	Refined copper
1956	385,196 tons	7628 tons
1957	403,929 tons	7848 tons
1958	411,000 metric tons	7966 m. tons
1959	405,000 tons	..
1964	473,000 tons	..
1965	468,000 tons	..

In 1964 the production of copper-ore was 473,000 tons valued at Rs. 24,121 thousand and in 1965 the production was 468,000 tons valued at Rs. 24,715 thousand.

Reserves

India is not fortunately placed as regards the copper ore deposits since only one unit is producing copper in India. The annual production of copper is about 7,200 tons per annum while the country's demand has been estimated between 25 to 30 thousand tons per annum distributed as : 12 to 15 thousand tons for electrical cable and wire; 8 thousand tons for utensils and hollow wire industry and 5 to 7 thousand tons for defence, railways, and other miscellaneous requirements. Therefore, there is a very wide gap to be filled up.

Trade

Hence we import large quantities of copper from U.S.A., Canada Rhodesia, Japan and Portuguese East Africa. This imported copper is used for high electrolytic materials, while the indigenous production is used in the manufacture of brass for utensil industry and other copper base alloys.

The imports of the copper metal for the last some years are as follows :

Year	Quantity (in 000 cwts.)	Value in Rs. crores
1954-55	540	8.7
1955-56	362	8.7
1956-57	701	16.1
1958-59	52336000 m. tons	134,272
1959-60	50840 tons	163,095,000
1960-61	63247	216,493
1961-62	62061	194,424
1962-63	71740	237,660

ALUMINIUM

Out of the family of non-ferrous metals aluminium is the only metal which has extensive ore deposits in the country. According to Dr. Fox there are two main classes of ores : (i) The Mediterranean type and the (ii) Indian type.[1] Commercial deposits of bauxite in India is the residual production of rock-weathering as well as by alteration of granite-gneiss, Vindhyan limestone and Vindhyan sandstone.

1. The former class includes bauxites of Spain, France, Italy, Yugoslavia and Rumania. These ores seldom contain more than 14 per cent of combined water.

While the bauxites of America, India and Australia belong to the latter class, they contain 22 to 30 per cent of combined water.

Distribution

In India there are four well-marked belts of bauxite deposits : The first belt is connected with the Deccan Trap region of the Peninsular India.

DECCAN TRAP REGION

In this belt the most important deposits of bauxite occur in Maharashtra in Kolhapur and Halar district in Saurashtra. In Kolhapur it occurs in Dhangarwadi hill. The reserves are estimated at 8-10 million tons. Bauxite also occurs in Kapadvanj in the Khaira District; in Thana District and in Satara, Surat, Poona and Ratnagiri District besides Bhir, Rajpipla and Baroda.

In Madras the important deposits are situated in Shevaroy hills in the Salem District. The total reserves of all grades of bauxite in this region are estimated at 7 million tons while the grade suitable for manufacture of aluminium are estimated at 2 million tons.

(i) In Mysore minor deposits of bauxite occur in Bababudan Hills. The bauxite deposits of Belgaum are estimated to contain about 7 lakh tons.

(ii) The second belt is represented by the region of numerous detached plateux formed of the gneiss near Lohardaga in the Ranchi and Palamau districts of Bihar. The reserves of high grade ore are estimated at about 10 million tons.

Although some bauxite deposits occur in Korla Pat in Kalahandi and Sambalpur districts of Orissa State, the total reserves of quality suitable for aluminium manufacture are estimated at less than 4 lakh tons. According to Dr. Krishnan, a band of yellow-coloured bauxite of good quality having a vertical thickness of 5 metre and a horizontal extent of 136 to 152 metres occurs in laterite on the western flank of the Korlapat Hill.

(iii) The third belt is constituted by the group of bauxite deposits derived from the Vindhyan rocks in the neighbourhood of Katni. Next to Bihar, Madhya Pradesh contains the most extensive deposits of bauxite in Surguja, Raigarh and Bilaspur region, Balaghat and Katni areas in Jabalpur District. The total reserves of bauxite of grades suitable for manufacture of aluminium metal in this State are estimated at about 7 million tons.

(iv) The fourth belt is represented by the diasporic deposits occurring in Kashmir in Poonch and Riasi areas. These deposits are diasporic in nature and are very refractory and not easily soluble in caustic soda. The reserves are estimated at a million tons.

Reserves

Our total known reserves of bauxite are estimated at 250 million tons of all grades. Of this high grade reserves would amount to 35

million tons distributed as Madhya Pradesh, 15.10 milliont tons; Bihar 5.23 million tons; Maharashtra 3.23 million tons; Madras, 2.00 million tons and Kashmir 1.00 million tons. Even at this estimate the aluminium industry with a capacity of 50,000 tons per annum can be assured of a supply for at least 150 years. These bauxite deposits, besides being large and of high quality, are also fairly evenly distributed. Looking to the geological strata in the different parts of the country, there is also a great possibility of more bauxite deposits being found and proved.

Production and consumption

In the last decade, the domestic aluminium industry has been consuming annually about 20,000 tons of bauxite which is less than 50% of the country's production. The greater part of the production is being used in the manufacture of alum, high alumina cement, refractories and in the refining of petroleum.

Metallic aluminium was first produced in India in 1943 but from imported alumina. Since then two companies have been producing aluminium and the alumina required for its manufacture is now produced from Indian bauxite. The two companies used in 1951 a total of about 19,000 tons for this purpose.

Table showing production, consumption, and exports of Indian bauxite.

Year	Production	Export	Available for consumption	Actual consumption by the aluminium industry	Actual consumption by the Cement industry	Quantity available for other uses
1948	22156	535	21621	..	..	..
1951	67047	808	66239	18538	6331	41370
1956	91225	4405	92092	45199	17125	29768
1957	96750	8490	116358	53844	19555	19212
1958	136907	20519	191369	66127	15839	46675
1959	217,991	23189	88260	49493	14325	110944

Some useful information regarding production, consumption and exports of Indian bauxite is given in the table. It shows that the annual production of bauxite for 1959 was an all time record—214558 tons. The pattern of consumption shown in the table above is very different from the nature of utilisation of bauxite in U.S.A. and other industrial countries. There 90% of the output is consumed by the aluminium industry. But in our country it is not so. However the requirements of our aluminium industry have been constantly rising and it is expected that the consumption will increase considerably within a few years.

There are two concerns which are producing aluminium in the country and their present installed capacity is about 7,500 tons per annum. As against this installed capacity, the quantum of demand for aluminium in all forms has been steadily rising.

The current requirement of India in regard to aluminium in various forms is estimated at about 25,000 tons per year, and by the end of 1963 it was 35 to 40 thousand tons. Thus, a wide gap has to be filled up. The production of this mineral in the year 1959 was 217,991 tons valued at Rs. 2,212,000, which had been achieved in 1960 because the production of bauxite in that year was 387380 metric tons. In 1965 the production of bauxite was 703,000 tonnes which was valued at Rs. 6783 thousand.

LEAD

The important ore of lead is *Galena* (sulphide of lead) which contains about 86% of the metallic lead. Other lead ores are cerrusite (which is carbonate of lead) which contains about 77% of the metallic content and Angestite (the sulphate of lead) in which the metal content is 68%.

Distribution of deposits

Although a number of occurrences of lead have been reported as scattered in places like Hazaribagh in Bihar, Gwalior, Datia and Drug in Madhya Pradesh, Udaipur and Jaipur in Rajasthan, the only commercially workable deposits are in the Zawar mines near Udaipur in Rajasthan. These deposits are worked by M/s Metal Corporation of India, Ltd., who are separating the lead concentrate from the mixed ore. The statistics reveal that the possible reserves are about 400,000 tons of combined metallic zinc and lead forms an equivalent of about 10 million tons of ore of all grades (12 to 13 per cent). The smelting and conversion are carried out at Tundoo in Bihar. The present position of production of lead concentrates in the country is about 5,532 tonnes in 1961 worth Rs. 1,691,000.

In India 162000 metric tons lead-zinc ores were produced during 1959. It was nearly 38% higher than the production in 1958 which amounted to 3,387 metric tonnes.

The recovery of lead concentrates was to the tune of 5341 metric tons in 1958, 6488 metric tons in 1959, 6245 tonnes in 1960 and 5532 tonnes in 1961.

The production of refined lead during 1959 was 3958 metric tons as against 3387 metric tons in 1958, representing an increase of 17%. The production of lead in 1964 was 6130 tons and in 1965 it was 5582 tons worth Rs. 3985 and 3629 thousand respectively.

The import of lead ore and concentrates into India were 104 and 112 metric tons in 1957 and 1958 respectively. They were valued at Rs. 334,000 in 1957 and Rs. 192,000 in 1958. Lead metal was imported to

the quantity of 14766 and 21844 metric tons in 1957 and 1958 respectively.

"As a metal, an alloying agent, an ingredient of manufactured goods, and an agent in industrial operations, the range of lead's usefulness is about as wide as the field of industry itself. It is present in the paint, plumping materials, glass-ware and musical instruments; in the office it is used in type-writers and calculating machines; in transportation large quantities are required in the manufacture of automobiles, airplanes, locomotives, batteries, and electric wires. It is valuable in the building trade, communication by wire, the printing industry, the sportsman's rifle and the chemical laboratory. In a word, after iron, it is the most commonly used mineral due to its lightness, softness and maleability. It is a bad conductor of heat."

ZINC

The largest use of zinc in the country is in the manufacture of galvanized iron sheets.

Zinc is a mixed ore containing lead and zinc. Its chief ore is zinc sulphide. But it is also obtained from calemine, zincite, wilemite and hemi-morphite.

In India the known resources of zinc ore are rather limited as there is only one commercially exploitable deposit in Zawar near Udaipur in Rajasthan. It is being worked by M/s Metal Corporation of India Ltd. No zinc is being produced in the country at present and the zinc concentrates containing about 50 to 54 per cent zinc is of the order of 5,800 tons. The Corporation is now installing more equipment in the ore-dressing plant, and it is expected that they will be able to treat in their milling plant 500 tons of ore per day. The production of zinc concentrates during 1961 was 9,254 tonnes.

Production

In 1958 and 1959 the production of zinc concentrates was 7391 and 9978 metric tons respectively, showing a substantial rise in production in 1959. But in 1960 there was a slight fall as the production fell to 9787 tonnes. There was further fall to 9254 tonnes. In 1964 and 65 the production of zinc was 4660 and 4209 tons respectively.

Trade

As there is no production of zinc in the country all the requirements of the nation are met by imports. The imports of zinc metal in 1957 and 1958 amounted to 54257 (valued at Rs. 72,425,000) and 60655 (valued at Rs. 61,30,400) metric tons respectively.

Zinc is imported from Rhodesia, Australia, U.S.A. and Holland.

Our present demand for zinc is of the order of about 50,000 tons a year and this demand is expected to rise to 70,000 tons by the end of

1967-68 as more zinc will be required for galvanizing larger production of steel sheets.

Reserves. Several small occurrences of lead-zinc ores have been noted in several places scattered over the country, and the possibility of some of them containing workable quantities should be investigated. Attention should also paid to the occurrence of zinc in the Hazaribagh district of Bihar.

The Zinc Committee has, therefore, reported that India should have proved reserves of ores to mine continuously up to the extent of 1,000 tons per day for a reasonable number of years in order to be able to establish and feed smelter of an economic size. M/s Metal Corporation of India, Ltd., are implementing their programme to develop these mines so as to raise 1,000 tons of ore a day which will be sufficient to feed a zinc refinery of 10 to 20 thousand tons per annum.

TIN

Tin ore occurs in the mineral Casseterite found in granitic rocks and occurrences were noted in Hazaribagh, Gaya and Ranchi districts in Bihar. Pits were sunk, several decades ago, at Narungo to a depth of 180 metres but the tin values are stated to have decreased with depth and the deposits were not considered an economic proposition. Small amounts of tin ore are found associated with Granite and Pegmatite at Chapatand, Seniratal and Chakkar-Bandha. Some work was done a few years ago on this deposit but the operations were not profitable. The deposits known so far have not yielded sufficiently encouraging results.

It is very deficient in tin and, therefore, every year we have to import it from Malaya, Singapore and other countries. At present India consumes about 4,000 tons of tin and 12,000 tons of tin plate annually in the electrical goods industry, the metal container industry and the pharmaceutical industry.

Our demand was about 7 thousand tons during 1963-64, due to increased production of tin plates and copper-tin base alloys.

Tin is of great use and is very largely employed in a number of uses. "It accompanies man in every walk of life literally from cradle to grave. It is a necessary ingredient of soldier, and is a component of habit and most other anti-friction metals, without which manufacture and transportation would be impossible. As foil, it wraps like the workman's tobacco and the school girl's confections. It accounts for rustle and lustre of silk so dear to feminine heart, while the tin dinner pail has a place in politics and is celebrated in song and story. Without humble tin can the world could no longer be properly fed."

ANTIMONY

Antimony is a useful alloy for mixing with softer metals. In India antimony deposits are found in Lahul and Kangra district of the

Punjab. A considerable quantity may also be obtained from the Chial drug district in Mysore. As no other workable deposits have so far been discovered, India has to import large quantities of these ores from abroad.

The installed capacity of the unit—Star Metal Refinery, Bombay—which is producing antimony is estimated at 1,000 tons per annum which is more than sufficient to meet the present demand estimated at about 600 tons. Our demand was 800 to 1,000 tons as a result of increasing consumption.

SALT

Salt produced in India is obtained from two main sources : (i) sea water; and (ii) brine in the lakes of inland drainage, especially the Sambhar lake. About two-thirds of the salt made in India is obtained from sea water, chiefly in Bombay and Madras; very little industrial use is made of Indian salt, as the production of salt in India consists of the so-called 'common salt' and not of industrial salts. The only industrial salt produced in India is saltpetre coming from Bihar and U.P. In 1950 we produced 7,000 tons of saltpetre. Nearly the whole of the quantity is exported to U.S.A., U.K., Mauritius, Ceylon, Malaya and Indonesia. A small quantity is used in Assam tea gardens.

As the production of common salt has a great political significance for the people of India—the famous Dandi March of Mahatma Gandhi is a landmark in the history of Indian freedom. We give below a detailed account of the salt production in India.

Ideal conditions for salt-making are :—

(i) Proximity to the sea to have easy access to brine,

(ii) Scanty or no rainfall,

(iii) Strong insulation, which in turn depends on cloudless skies,

(iv) Moderate to strong winds,

(v) Moderate to high air temperature with large deficiencies of moisture,

(vi) Moderate to high evaporation which depends upon the foregoing factors.

From this point of view the following are suitable areas for salt-making in India :—

(i) The Saurashtra coast,

(ii) Southern half of the Coromondal Coast, between Nagapatam and Cape Comorin,

(iii) North Andhra—Madras Coast between Nellore and Gopalpur,

(iv) The Sambhar Lake.

The table[1] below compares the climatic conditions found in the salt-making centres in the above areas :

	Annual Rain	No. of Rainy days	Mean Air Temp.	Mean Humidity	Mean Evaporation
Dwarka	13.52″	20	78	75	98.12
Pamban	37″	30	82	75	88.40
Gopalpur	44.96″	60	80	75	89.58

The largest production of salt in India is from the western coast. Maharashtra State ranks first in salt production. Most of the salt in Maharashtra is made by the direct solar evaporation of sea water. The factories at Dharsana, Bhoyandar, Bhandup Uran and Mithapur and Chharvada on the eastern side of the Gulf of Cambay near Bulsar and Okha in Saurashtra belong to the Government. The other sea salt works are grouped within a radius of thirty miles of the city of Bombay. Those which are owned by the Government are leased to private persons for working; while the others are owned and worked privately. A site for a salt works is chosen generally below the level of high water in spring tides and surrounded by strong embankment. Within this are situated the outer and inner reservoir and the 'pan' area. The outer reservoir is filled when the tide is high; from it the water flows to the inner reservoir, and thence to the crystallising pans. The floors of the crystallising pans in Bombay, and elsewhere generally, have their floors levelled and stamped with clay which gives the muddy colour to salt. After a few days when a layer of salt, about a quarter of an inch thick, has formed on the bed of the pan, it is raked to the edges of the pan, washed, allowed to dry and then separated into different sizes. The pan is filled again with water and the process repeated.

The season of manufacture varies with the south-west monsoon, January to June being the normal period.

A considerable proportion of the Bombay salt is Baragra of Rann salt, made from salt water derived from wells on the little Rann of Cutch. The largest works at the Rann are at Kharagoda and Kuda. There the salt water is obtained from circular wells about 9 feet in diameter and about 18 to 30 feet deep. Here the saline content of the water is very high. The manufacturing season here lasts from November to April.

On the east coast, salt is manufactured in Madras and Andhra States from the district of Ganjam to Tuticorin to the extreme south. The salt works are at Nanpada, Pennuguduru, Madras, Cuddalore, Adirampatnam and Tuticorin State much on the same lines as in Bombay. The sea water is usually brought from tidal backwaters through channel from which it is baled into condensing beds. In some works the pans

1. Scientific Notes, Met., Deptt. India Vol., VI 1935.

are irrigated several times before the layer of salt crystals is removed, but the 'single irrigation' system is the most common. The season of manufacture varies according as the salt works are subject to the south-west or the north-east monsoon. In the northern districts, manufacture commences in January or February and continues till June or July, when the rains begin. On the South, manufacture commences later, in March or April, and continues up to October or November. Madras salt is consumed locally, and some of it is exported to Ceylon. Some is also sent to Orissa, West Bengal, Mysore, and Madhya Pradesh.

The whole of the desert region of Rajasthan is impregnated with salt from the coast of Cutch, north and north-eastwards to the borders of Delhi. In this area there are many temporary or permanent salt lakes as for example, the *Sambhar* and *Didwana*, which are utilized for salt making; while in other places sub-soil salt water is raised, as at *Pachbadra.* Most of the salt in this region appears to be brought in as fine dust by the strong winds which blow from the south-west during summer. These winds blow across the salt-incrusted Rann of Cutch, and carry away sea-spray and finely-powdered salt in large quantities into the heart of Rajasthan where it remains deposited until the monsoon brings enough rain to wash it into the small lakes in the areas of internal drainage.

The Sambhar is the largest of these salt lakes and covers an area of about 90 square miles at its highest level, but dwindles, generally, to a small puddle by March or April. The mud forming the bed of the lake contains an average about 5% of salt down to a depth of at least twelve feet. According to Christie there are more than 55 million tons of salt in the upper 12 feet of the silt. When the lake dries up, salt water contained in its clay bed rises to the surface by capillary action and is evaporated there.

A big dam has been built across the lake near the Sambhar town, and water from the main lake is pumped into a reservoir thus formed. From this reservoir it is transferred to smaller reservoirs and thence to evaporating pans. More than three-fourths of the Sambhar salt is consumed in U.P. and Rajasthan, Punjab, Delhi, and Madhya Pradesh.

The largest production of salt in India is from the Sambhar Lake which yields about 10,000,000 mds. of salt annually.

The total area of salt pans in India amounts to 33,354 hectares. These pans produced about 34,62,000 tonnes valued at Rs.76,11,80,000. The consumption of salt in India is mainly for human food. A small amount is also given to animals. The use of salt for industrial purposes is negligible here owing to industrial backwardness. That is why the per head consumption of salt here amounts to 8 lbs. as compared to the world's average of 30 lbs. The following table shows the salt requirements of India :—

Table and other household purposes ..	2.07	m. tons
Livestock and other agricultural uses ..	0.03	"
Fish curing	0.01	"
Dairy products	0.01	"
Hides and Leather	1.07	"
Industrial uses	0.31	"
	3.50	m. tons

In 1959 the country became not only self-sufficient in salt but had an exportable surplus of over 200 lakh maunds.

The total number of labourers employed in salt industry in 1958 was 31,046 out of which 3,278 were employed in the public sector. The average number of labourers employed per day in Govt. Salt factories and other factories during 1950-60 was 28,810 in Salt factories in Gujarat, Maharashtra, Rajasthan, Andhra Pradesh, Kerala, Madras, Orissa and West Bengal.

The Rock salt in India is now available only from the Mandi State in the Punjab. The salt is quarried at two localities—Drang and Guma, which are 22 kilometes apart. The salt is of dark purplish colour and contains earthy impurities to an extent of about 25 per cent.

The First Five-Year Plan envisaged a production of 837 lakh maunds (3.1 million tons) in 1955-56. This target was surpassed in 1953 when the production amounted to 861 lakh maunds (3.16 million tons). The Second Plan target had been kept at 1000 lakh maunds (3.7 million tons) which has already been surpassed in 1958 when the production of salt was 1125 lakh maunds (4.1 million tons). Under the Third Plan developments were proposed along the following lines : The programme for the development of the salt industry in the private sector includes establishment of laboratories and model farms, improvement in brine supply channels, installation of plant and machinery. In the public sector, the rock salt mines at Mandi are to be developed on scientific lines by sinking shafts, as a result of which salt production will increase to 4 lakh mds. per annum as against 1,50,000 mds. at present.

As there is surplus production of salt in India, it is exported to Nepal, Indonesia, Japan, Malaya and Maldives.

The exports of salt during the last few years have been as follows :—

(in lakh maunds)

1955 ..	66.78	1957	119.40	
1956 ..	83.96	1958	79.51	
		1960	4.49	Lakh metric tons
		1961	1.58	"
		1962	1.65	"
		1963	2.68	"

Gold

India is very poor in precious ores. Silver is entirely absent, while only a small amount of gold occurs in a corner of the Deccan tableland. Practically all the gold mined in India comes from the Kolar fields in Mysore. The quantity of gold produced increased from 9 ozs. in 1882 to 2.5 lakh ozs. in 1943 and 2,20,522 ozs. in 1954. Total production of gold from existing mines reached 4868 kilograms valued at Rs. 59,103, thousand in 1961 as against 4995 kgs. worth 56,674 thousand rupees in 1960. In the Kolar field there is a single vein or reef averaging only some four feet in thickness in which gold occurs for a distance of about five miles. There are four mines in the state, *viz*., Mysore, Nandydroog, Oregaum and Champion Reef. The deepest mines are Champion Reef and Oregaum which have each reached a depth of considerably over 2743 metres measured vertically. This is the greatest depth of gold mine in the world. Owing to great depths the problem of ventilation is a serious one in these mines. The temperature in the lowest workings range from 118°F. 122°F. This depth is also responsible for the large number of accidents that occur in the mines owing to

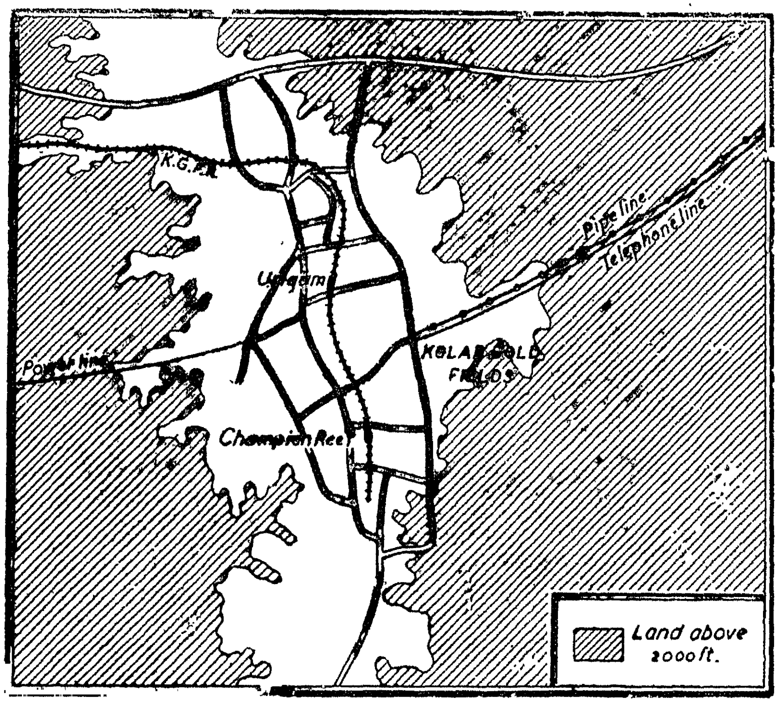


Fig. 54. Showing Gold Mines near Mysore

rock bursts. The mines are supplied with electricity from Siva Samudram on the river Cauvery.

The only other working mine Hutti in Andhra—is of minor importance. Gold-bearing veins are also known to exist in Dharwar district of Mysore; Wynaad and Anantpur districts of Madras and Lava in Manbhum district of Bihar. These occurrences show signs of old workings.

Besides this gold vein, a little alluvial gold is also washed from the sand of the rivers of Assam and Orissa. Some gold is also procured from alluvial soil of the rivers in Bijnor district of U.P., Ambala district of the Punjab and Singhbhum area of Orissa.

GYPSUM

Gypsum ranks next to coal and iron as a mineral of great importance in the industrial economy of the country. Before the second world War, it was used mostly as a raw material in the production of cement and plaster of Paris. It has now gained in importance as a raw material in the manufacture of ammonium Sulphate, an important fertilizer. It can be used as a source of sulphuric acid.

Distribution oi deposit

Gypsum deposits are known to exist in several parts of India. The more well-known gypsum-bearing regions are in Rajasthan and in South India, but smaller deposits occur also in Tehri, Garhwal, Himachal Pradesh and parts of western India.

Rajasthan. The most important deposits are in the Jodhpur, Bikaner and Jaisalmer divisions of the State.

Madras. Gypsum in thin veins varying in thickness from a fraction of an inch to 6 inches and associated with clays occurs in the Tiruchirapalli district. The reserves of gypsum in the gypsum-bearing clays in this area have been estimated at 15.3 million tons to a depth of 16 metres but the working of this gypsum is likely to be attended by a large percentage of loss. Thin beds of gypsum also occurs in Sulurpet and Nellore districts.

Gujarat. Gypsum in veins and thin beds and as crystals distributed in sedimentary strata is also found in Saurashtra and Kutch.

Northern India. Small deposits of gypsum as pockets and thin beds are also known to occur in the Dehra Dun, Nainital and Tehri-Garhwal regions of Uttar Pradesh. Among the outer deposits are those in the Sirmur district of Himachal Pradesh, which are estimated to contain about 1 million tons.

Production

The annual production from Indian deposits from 1952 to 1965 is given below.

TABLE CXXI : *Production of Gypsum in India*

Year	Output (000 tons)
1952	411
1953	586
1954	612
1955	700 000 metric tons
1956	867 " " "
1957	936 " " "
1958	794 " " "
1959	860 " " "
1960	997 " " "
1961	866 " " "
1962	1,124 " " "
1964	8,83,000 tons
1965	1,148,000 tons

Demand. The entire output is consumed in the country for the manufacture of fertilizers, cement and plaster of Paris. The annual requirements of the Sindri fertilizer factory is about 600,000 tons of gypsum. At present, the annual estimated consumption of gypsum is about 94,000 tons for cement manufacture and about 2,000 to 3,000 tons for plaster of Paris. About 37,500 tons of gypsum are required for the manufacture of ammonium Sulphate by the Fertilisers and Chemicals Ltd., Travancore.

Chromite

Chromite is an important strategic mineral of which India has moderate supplies.

The chief chromite deposits in India are situated in the Singhbhum district of Bihar, the Mysore and Hassen districts of the Mysore state, the Ratnagiri and Sawantawadi areas of Maharashtra, the Krishna and Salem districts of Madras and the Keonjhar district of Orissa.

There are also deposits near Dras in Ladakh, Kashmir, but these are practically inaccessible. Small reserves of chromite are found in Assam, Manipur and Andaman Islands.

Production and Export

The following table shows details regarding production and export of Chromite ore.

TABLE CXXII : *Output and Exports*

(000 tons)

Year	Output	Exports
1953	66	15
1954	45	23
1955	89	48
1956	56	42
1957	79	41
1958	64	49 (000 metric tons)
1959	85	82 ,,
1960	100	41 ,,
1961	46	41 ,,
1962	66	16 ,,
1964	349,69	—
1965	598,13	—

Reserves

The exact estimates of the reserves of chromite in the Indian union are not available. But the following figures may be given as general indications—

Mysore	135,000 tons
Maharashtra	67,000 tons
Orissa	200,000 tons
Salem	200,000 tons
Krishna	200,000 tons

Sulphur

Sulphur, a mineral of strategic importance, occurs in nature in the form of native sulphur and also in combination in the form of pyrites (iron Sulphide) and other metallic sulphides and as sulphates, *e.g.*, gypsum, anhydrite.

Distribution. Native Sulphur in deposits of large size in unknown in India, though recently some occurrences have come to light in the hill ranges to the north of India and small deposits of native sulphur produced by bacterial action on sulphates derived from sea-water have been found in the coastal tract of Masulipatam (Krishna district of Andhra Pradesh) and also in the Barren Island. Deposits of pyrites are more widespread and are found in Kashmir, at Taradeir near Simla, at Amjor near Rohtas in Bihar, Karwar in Maharashtra and in Chitaldrug

area of Mysore. There are substantial quantities of pyrites associated with the gold deposits of Wynaad in the Nilgiri district of Madras.

Consumption of Sulphur. As there is no production of sulphur in India, the country's requirements have to be met by imports from abroad. The following table shows the imports of sulphur in recent years.

TABLE CXXXIII : *Imports of Sulphur in India*

Year	Quantity (Cwts,)
1954-55	1,519,485
1955-56	1,695,411
1956-57	1,999,142
1958-59	108,801 tons
1959-60	136,946 ,,
1960-61	178,904 ,,
1961-62	191,433 ,,
1962-63	248,031 ,,
1963-64	125,701 ,,
1964-65 Jan. to June	120,305 ,,

Magnesite

Large deposits of magnesite, which is used in the manufacture of magnesium salts, metallic magnesium and refractory bricks are known to occur in a number of places in Salem (Madras); Hassan, Mysore in Mysore, Almora in U.P., Dungarpur in Rajasthan and Singhbhum in Bihar.

Of these, the chief producing centres are Salem, Assam and Mysore.

About a half of the output is used in the manufacture of refractory bricks for steel works and a considerable quantity is exported. The output and export of magnesite from 1953 to 1965 are given below—

TABLE CXXIV: *Output of Magnesite*

Year	Output tons	Exports (Cwts.)
1953	92,748	850,658
1954	70,507	507,236
1955	57,509	492,745
1956	91,711	690,920

1957	88,885	428,858
1958	104,236 metric tons	19,899
1959	157,967 ,, ,,	27,988
1960	156,331 ,, ,,	27,670
1961	209,744 ,, ,,	31,932
1962	217,371 ,, ,,	32,062
1964	208 tons	—
1965	235 tons	—

Ilmenite and Titanium

Ilmenite is concentrated in certain areas along the beaches of Kerala and Maharashtra states between Nandikaria, north of Quilon, on the West Coast, to Cape Comorin and up the east coast of Lipurum in Tirunelvelli district, a distance of nearly a hundred and sixty kilometres. Smaller patches of similar sands also occur on the beaches of the Malabar, Ramanathapuram, Tan ore, Visakhapatnam, Ganjam and Ratnagiri districts.

India's reserves of ilmenite in beach sands is estimated at 350 million tons. Beach sands in Chawara, near Quilon, Kerala, where most of the ilmenite was mined in 1963, contain 65 to 75 per cent ilmenite, 3 to 4 per cent rutile, 5 to 10 per cent zircon, 5 to 10 per cent sillimanite, 5 to 10 per cent quartze, and about 1 per cent monazite.

Despite the abundance of ilmenite in India's beaches, changes in titanium dioxide production technology (England and America), development of new sources, Government (Kerala) policy, technical difficulties in separating impurities in Indian ilmenite, and a high ferric iron content, have led to a steady decline in production of ilmenite since 1956. India, which was the World's leading supplier of ilmenite prior to World War II, and was second only to the United States until 1960, was the ninth leading World producer in 1963.

Travancore Titanium Products Ltd., the only Titanium-pigment producer, planned to increase daily output at its Trivandrum, Kerala, plant from 11 tons to 20 tons. The company was operating a pilot plant to use its waste sulphuric acid for manufacturing ammonium sulphate by a German process. The Kerala Government was considering a proposal to build a new 27 ton-a-day titanium dioxide plant as part of a growing chemical industry complex at Alwaye. By-product sulphuric acid from a proposed zinc smelter at Alwaye would bring India's annual titanium dioxide production capacity to about 20,000 short tons compared with the present capacity of 4,000 tons. Annual consumption was estimated at 35,000 tons in 1963.

Atomic Energy Minerals

In the Indian Union, some of the atomic, minerals are found in deposits. Of them, Uranium, thorium, vanadium and molybdenum are by far the most important.

Uranium

Uranium is used principally for weapons production and as fuel for power, propulsion and irradiation reactors.

A uranium mine at Jaduguda in Bihar state was geared for the production of about 1,000 tons per day sometime in 1964.

The Tarapur nuclear power plant to be built 99 kilometres north of Bombay will generate 380 megawatts when in operation as planned for 1968. The United States will lend up to $80 million for design and construction of the estimated $115 million plant. It will be fuelled with rich uranium from the United States, which also has the first option on the plutonium to be produced in the reactor.

The chief deposits are in Rajasthan, Kerala, Madras and Bihar. Of these, the chief producing centres are Trivandrum and Gaya.

Canada has also planned to build India's second nuclear power plant, a 200 megawatt "Candu-type" station at Rana Pratap Sagar in Rajasthan.

Thorium. Thorium is mostly used in magnesium alloys and gas mantles. Magnesium containing up to 3 per cent of thorium retains a much higher strength between 400° and 600°F. The popularity of thorium alloys increased during 1963 and Atomic Energy Commission (AEC) proposed amending its regulations to exempt such alloys from licensing. Significant amounts of thorium were also used as refractories, and in chemical products and electronics. Thorium was used as a reactor fuel in research and development facilities.

Powerplant proto-type reactors using thorium presently in operation or in an advanced stage of construction are—

1. Apsara, India's first research reactor, the first reactor in Asia outside the U.S.S.R., attained criticality on August 4, 1956. It was designed, engineered and built entirely by the engineers and scientists of the Trombay establishment except for the fuel elements which were provided by the United Kingdom Atomic Energy Authority under agreement.

2. C.I.R. or the Canada India Reactor—is India's second reactor, being a joint Indo-Canadian Project under the Colombo plan. It is a natural Uranium filled, heavy water moderated and light water cooled high flux research reactor with a thermal power of 40 M.W.

3. Zerlina is India's third research reactor. Initially, Zerlina will operate on natural uranium fuel in the form of rods, heavy water as moderator and graphite as reflector.

4. A nuclear power station of the capacity of 200 mw. is also under construction at Rana Pratap Sagar in Rajasthan and is expected to be commissioned in 1969-70.

Extension of the Rana Pratap Sagar nuclear station by 200 mw. and the establishment of the next nuclear station of 400 mw. capacity at Kalpakkam in Madras state have been sanctioned under the 4th Plan.

Vanadium. It is an atomic energy mineral. Reserves of Vanadium exist in the States of Orissa, Bihar, Andhra Pradesh and Kerala. The chief producing centres are Gaya, Mayurbhanj, Hazaribagh and Nellore.

Molybdenum. This mineral occurs in Madras, Bihar, Andhra Pradesh and Kerala. Chief mining areas are Chhota Nagpur plateau, Godavari Valley and Madurai.

The Government is now giving greater attention to the mining industry in India. A Bureau of Mine has been established to achieve greater progress.

QUESTIONS

1. Examine the World position of India as a producer of raw minerals.
2. Write an essay on the supplies of Iron ores and their utilization in India.
3. Examine the prospects of India becoming a "Big power".

CHAPTER 22

Changing Pattern of Indian Industry

India's economy centres round her agriculture which provides her people with food and raw materia ls. Under ordinary circumstances Indians have been quite content to follow their forefathers' occupation—agriculture. Even the rudimentary manufacturing that has existed in the country for long, has been associated primarily with agriculture.

The intimate contact with the foreigners and the consequent growth of an urban population in India led to a rise in the standard of living of the people. Articles which were formerly considered luxuries became necessaries of life. The demand for manufactured articles thus grew considerably. A very large section of the urban population became entirely cut off from agriculture. The natural corollary of this separation from land was that, in due course of time, the city-dwellers started manufacturing enterprises on western lines. The beginning of industrial enterprise in India were started first by the Europeans, but were later on, taken up by the Indians themselves. The first industrial magnates hailed from the two largest towns of India, Calcutta and Bombay, where the Western influences were most dominating.

Industrial activity in India spread from the port towns of Bombay and Calcutta, not only because of the Western influences, but also because of the ease with which machinery and stores could be imported from Europe through these ports. These towns were already large business centres, and as such, supplied banking facilities so necessary for industrial enterprise.

Another advantage enjoyed by these port towns for industrial enterprise was that most of the raw materials and other exports were accumulated there to be shipped abroad. These facilities were fully taken advantage of by the new industrialists.

India is still backward in manufacturing industries. The development of 'key industries', like the Iron and Steel and the Chemical industries, the products of which are essential for the general industrial development has not advanced far in India. The main cause of this backwardness of the 'key industries' and the consequent backwardness of industries in general, is due largely to the defective distribution and

poverty of coal resources of the country. Indian coal lies mostly in a remote corner of the Peninsula where means of communication are deficient. Compared with this, the coal resources of the United States of America and England and of Germany lie in well-developed regions. The water communication provided by the rivers serving the coal region there has been of fundamental importance in developing the coal. These communication facilities also helped in attracting manufacturing industries to it. The inferiority of the quality of the Indian coal has already been noted elsewhere in this book.

Changes after Independence

After independence, India has been developing from backward and agrarian economy into an industrial country. The rate of progress in this direction can be judged from the fact that since 1947 the overall industrial production has increased by 6 times whereas the means of production by 9.3 times; and the consumption goods by 1.9 times. Traditionally, our industrial ideas are confined to crafts and hand-work. The last fifty years of our history have made us familiar with the use of machine but that only at relatively simple processes, such for instance as in a cotton mill, a coal mine, a jute factory or a tea garden. In the new horizon that we have thought fit to set for ourselves, however, a much more complicated use of machine is needed and the public must be more familiar with it.

Above 9161 factories are working today employing roughly 153,000,000 workmen. The summary of census of Indian manufactures for 1948-65 reveals quite interesting data and are worth detailed analysis. The number of factories were 6,144 in 1948-49; 6753 in 1950-51; 7099 in 1952-53; 6979 in 1954-55; 7,665 in 1956-57; 8704 in 1960-61 and 9161 in 1964-65.

The percentage increase in output of various industries on the 1950-51 level has been phenomenal—165 per cent in Steel manufactures, nearly 69 per cent in coal, nearly 250 per cent in cement, over 250 per cent in Sugar, 25 percent in Cotton, 33 percent in Tea and 100 percent in case of paper and Board. Similar increases are recorded in other industries as well. Our electricity production is to mount from 3.5 million Kw. to 29 billion Kwh. a year, coal from 36 million to 644 lakh-tons a year, finished steel from 1.3 million to 44.3 lakh tons a year, aluminium from 5,000 to 54,000 tons a year and cement 4 million to 98 lakh tons a year. The whole pattern of industrial economy is being geared to a higher structural elevation and all that against an expanding horizon.

Industrial Changes

The basic fact of India's industrial life is a new and expanding horizon. The smart increase in industrial production since independence

is reflected in the upward trend of the general index of industrial production. The index which stood at 97.2 in 1947 steadily rose to 184.0 in 1965, the best year for industry since independence. This rising trend has been well maintained in 1962 also, the general index for the first quarter of this year being 150.7. Stable conditions have been restored in trade and industry and the country is well on the way to self sufficiency in a number of consumer goods. Another indication of the rising industrial production is provided by the fall in commodity price. The price index dropped from 399.6 at the beginning of 1954 to 367.8 at the end of the year. Since then there has been a further increase in the price index.

Changing Industrial pattern in Basic Industries

The industrial pattern of the Indian republic is expanding from the old concentration in consumer good industries to the industries manufacturing producers goods. While there is a distinct shift towards new basic and new heavy engineering industries, the main lines of new developments are in the directions of light engineering and industrial stores and raw materials field. Among such new or virtually new industries are aluminium among the basic industries; lead and magnesium among the mining industries; locomotive, boilers, diesel engines, road rollers and automobile among the heavy industrial group; and all the host of new lines in light engineering, heavy chemicals, processing industries and drug and anti-biotics field. Apart from the items listed above, other items of production in the former field are wire nails, wood screw, bolts and nuts, storage batteries, hardwares and abrasives; whereas in the latter field are mineral oil refining, dyes, sulphuric acids, paper and packing and packaging containers. The tendency in both the fields is more or more towards specialised production. India did not produce any electric motors before independence but her production of these motors is now at the rate of over 200,000 H.P. a year. Production of electric motors in 1959-60 was 90.6 thousands. India did not produce any sewing machine before independence but her production of these machines to day is at the rate of nearly over 80,000 machines a year.

In the modern World Iron and Steel is of basic fundamental importance not only for agriculture and transport but also for all classes of industries, more particularly the engineering and defence industries. Thus in any programme of agricultural and industrial development for improving the general condition of life, the first place has necessarily to be given to an expansion of the indigenous Iron and Steel industry, supplying the basic raw material for factories, tools and implements, machinery, tractors and houses, electricity, automobiles, locomotives and steam-ship and all the rest that go to make for better conditions of living. In India, both metallurgical coal and iron ore are found within a distance of 320 kilometres from each other involving comparatively

small transport charges. Then the reserves of high grade ore are almost inexhaustible. In the Singhbhum region alone there are over 1,500 million tons of iron ore sufficient to last for at least 1.5 thousand years. The only snag is that according to present estimates the reserves of iron ore are not matched by an equal sufficiency for high quality metallurgical coal for coking purposes but this problem can be got over by benefication of low grade coal by processing them in a modern washery. Before partition the iron and steel major panel fixed a target of 2.5 to 3 million tons. When the National Government came to power in 1947 they energetically took up this the most essential and basic question to adequate indigenous supply of Steel. They estimated the immediate demand at 2.4 million tons. But in actual practice, we find production stagnating at 1.4 million ingot tons. The Planning Commission's target for the First Five Year Plan was 2.8 million tons to be reached by 1955-56 as against which the Second Five Year Plan has fixed a targe t of 6 million tons to be raised thereafter to 10 million tons. For a country with one-seventh of the World's population even this 10 million ton target appeass to be modest. So that, the target for Steel production in the third Plan was about 17 million tons, an increase of 8 million tons over the Second Plan target.

THE INDUSTRIAL POLICY

During the first plan, considerable progress was made in the industrial sector. The index number of industrial production, which stood at 100 in 1951 rose to 103.6 in 1952; 105.6 in 1953; 112.9 in 1954; 122.1 in 1955; 133.0 in 1956; 137.2 in 1957 and to 141.0 in May 1958. A number of industrial projects have been completed in the public sector. The Sindri Fertilizer factory (Sindri, Bihar), Chitranjan Locomotive factory (Chitranjan, Mihijam); Indian Telephone Industries (Duravaninagar near Bangalore). The Integral Coach Factory (Perambur, Madras); the Cable Factory (Rupnarainpur) and the Penincillin factory made good progress in production.

But few others like the Machine Tool factory (Jalahalli, Bangalore), Cement factory; (Nepanagar) and Bihar Superphosphate factory (Sindri) lagged behind Schedule.

The targets of production laid down in the First Plan have been exceeded in the case of cotton textiles, sugar and vegetable oils. They have been attained more or less in the case of cement, paper, soda ash, caustic soda, and other chemicals, rayon, bicycles and certain other industries. Short-falls have occurred in aluminium and nitrogenous fertilisers in the Private sector and in light engineering industries such as diesel engines, pumps, radios, batteries, electric lamps, lanterns—the latter due mainly to lack of domestic demand.

Diversification of Industries

During the First and Second Plans (1951-52 to 1960-61) there have been notable growth and diversification in Indian industry. The Second Plan period has been particularly remarkable in this respect. The index of industrial production rose from 100 in 1950-51 to 194 in 1960-61. A number of industrial projects have been completed in the public sector. Three new steel works, each of 10 lakh tons capacity, were completed and two existing steel works in the private sector doubled their capacity so as to bring their ingot capacity to 20 lakh and 10 lakh tons respectively. In the field of heavy engineering industry, the foundations were laid of heavy electrical and heavy machine tools industries. The production of machinery for cement and paper industries started for the first time. A number of new chemical products were manufactured such as urea, ammonium phosphate, penicillin, synthetic fibres, newsprint and dyes truffs and so on. There was a greatly increased output of the basic chemicals such as nitrogenous fertilizers caustic soda, dosa ash and sulphuric acid etc. The output of such industries as bicycle, sewing machine , telephones, electrical good , textile and sugar also increased.

Nevertheless, there have been some short-falls also. The combined output of the new steel works was only 6 lakh tons in 1960-61 as against the target of 20 lakh tons. The production of the Tata Iron and Steel Works was also below the mark. The expansion of the Government Sindri fertilizer factory and the three new fertilizer plants in the public sector at Nangal, Neyveli and Rourkela have all been delayed. The Heavy Electrical Project at Bhopal is also delayed

Most of the other targets of capacity and production have been almost completed and in some cases the targets have been exceeded such as diesel engines, electric motors, electric fans, radio receivers and sugar etc.

The actual expenditure in many projects has exceeded the estimates as laid down in the beginning of the Second Five Year Plan. The main reason was the lack of experience in project engineering.

The Third Five Year Plan was laid greater emphasis on the establishment of basic capital and producer goods industries, with special emphasis on machine building programmes. The Third Plan has laid down the following priorities for the development of industries in the country :—

(i) completion of incomplete Second Plan projects;
(ii) increased production of major basic raw materials and producer goods like aluminium, mineral oils, and dissolving pulp etc.
(iii) increased production from domestic industries of commodities required to meet essential needs like essential drugs, paper, cloth, sugar etc.

(iv) expansion and diversification of capacity of the heavy engineering and machine building industries, castings and forgings, alloy tool and special steels etc.

The following table shows the production of selected industries in different years since 1960-61.

TABLE CXXV : *Production in Selected Industries*

	1960-61	1961-62	1962-63	1963-64	1964-65
I. *Mining*					
1. Coal (lakh tons)	555	552	638	663	644
2. Iron ore (lakh tons)	110	130	138	148	151
II. *Metallurgical Industries*					
3. Pig Iron (lakh tons)	43	51	61	66	66.7
4. Steel Ingots (lakh tons)	35	43	54	59	61.4
5. Finished Steel (lakh tons)	24	30	40	43	44.3
6. Steel Castings ('000 tons)	34	40	44	50	55
7. Aluminium (Virgin metal '000 tons)	18.3	19.9	42.6	54.0	54·1
8. Copper (000 tons)	8.3	9.2	9.7	9.6	9.4
III. *Mechanical Engineering*					
9. Machine tools (lakh rupees)	700	930	12.60	20.10	25.70
10. Railways wagon ('000 nos.)	8.2	11.2	15.7	20.4	24.2
11. Automobiles (000 nos.)	55.0	54.6	54.8	56.7	70.8
(i) Commercial Vehicles (000 nos.)	28.4	25.4	26.5	29.5	36.8
(ii) Passenger cars (000 nos.)	26.6	29.2	28.3	27.2	34.0
12. Motor Cycles and Scooters (000 nos.)	19.3	23.2	23.8	24.0	37.4
13. Power Driven pumps ('000 nos.)	10.9	1.35	1.32	1.53	1.84
14. Diesel Engines (000 nos.)	44.7	43.4	45.3	57.7	74.1
15. Bicycles (000 nos.)	10.71	10.43	11.11	12.59	14.42
16. Sewing machines (000 nos.)	3.03	3.25	3.47	2.82	3.30

IV. *Electrical Engineering Industries*					
17. Power Transformers (lakh k.v.a.)	14.1	19.5	24.2	27.6	3.56
18. Electric motors ('000 h. p.)	7.28	8.73	10.4	11.82	14.36
19. Electric Fans (lakh nos.)	10.6	10.7	11.7	10.7	12.75
20. Electric lamps (lakh nos.)	4.35	4.88	6.16	7.18	6.81
21. Radio receivers ('000 nos.)	2.82	3.43	35.8	4.13	5.12
22. Electrical cables etc.					
(i) Aluminium conductors (000 tons)	23.7	22.6	31.6	33.0	48.4
(ii) Bare copper conductors (000 tons)	10.1	7.1	4.2	5.2	5.3
V. *Chemical and Allied Industries*					
23. Nitrogenous Fertil zers (000 tons of N.)	99	1.45	1.78	2.19	2.33
24. Phosphatic fertilizers (000 tons of P_2O_5)	54	63	80	1.08	1.31
25. Sulphuric acid (000 tons)	3.68	4.30	4.85	6.02	6.95
26. Soda ash (000 tons)	1,52	1.83	2.36	2.74	2.86
27. Caustic Soda (000 tons)	1.01	1.23	1.30	1.63	1.92
28. Paper and paperboards (000 tons)	3.50	3.67	4.01	4.78	4.94
29. Rubber tyres					
(i) Automobiles tyres (lakh tons)	14.4	16.0	17.6	19.7	21.5
(ii) Bicycle tyres (lakh tons)	111.5	113.3	124.3	148.4	164.5
30. Cement (lakh tons)	79	83	88	94	98
31. Refractories (000 tons)	5.67	6.31	6.86	6.45	6.91
32. Petroleum Products (lakh tons)	58	62	69	80	84
VI. *Textile Industries*					
33. Jute textile (000 tons)	10.71	10.01	12.02	12.48	12.92
34. Cotton Yarn (crore kg.)	80.1	87.3	85.7	91.6	96.2

35. Cotton cloth (crore m.)	673.8	711.5	700.0	741.0	774.5
(1) Mill rector (crore m.)	464.9	468.5	449.8	448.4	467.6
(2) Decentralised sector (crore metres)	208.9	242.9	250.2	292.6	306.9
36. Rayon Yarn (000 tons)	43.8	52.1	62.1	67.9	72.2
37. Woollen manufactures :					
(a) Woollen and Worsted Yarn (lakh Kg.)	1.30	1.58	1.96	2.27	2.03
(b) Woollen and Worsted Fabrics (lakh m.)	1.33	1.45	1.89	1.91	1.12
VII. *Food Industries* :					
38. Sugar (Nov. Oct.=lakh tons)	30.3	27.1	21.5	25.7	32.6
39. Tea (crore Kg.)	32.0	35.2	34.3	34.2	37.3
40. Coffee (000 tons)	54.1	66.7	49.0	61.2	63.4
41. Vanaspati (000 tons)	3.40	3.41	3.66	3.98	3.66
VIII. *Electricity (generated billion kwh.)*	17.0	19.8	22.1	25.9	29.0

Some indication of the industrial pattern of India may be available on a comparative basis from a table CXXVI of the number of people engaged in industries and public utilities and their relative percentage to the total number of economically active population in each industry.

TABLE CXXVI : *Workers Employed in Industries*

Industry	Average No. of workers employed daily
Processes allied to agriculture	148,034
Food Except beverages	489,087
Beverages	6,887
Tabacco	191,431
Textiles	1,140,766
Footwear etc.	18,526
Wood and Cork except furniture	43,190
Furniture and fixtures	13,528
Paper and paper products	35,293
Printing and allied industries	94,211

Leather and its products	19,780
Rubber and its products	31,388
Chemicals and Chemical products ..	119,464
Products of petroleum and coal	16,694
Non-metallic mineral products	158,236
Basic metal industries	133,029
Metal products	103,638
Machinery etc.	146,205
Electrical machinery etc.	146,174
Transport equipment	300,674
Miscellaneous Industries	100,246
Electricity gas and steam	35,575
Water and Sanitary Services	6,498
Recreation Services	4,704
Personal Services	10,727

The larger the percentage of population relatively employed in industries the more must the industrial structure of a country lean towards capital goods and specialised services and more must it, relatively, switch away from the consumer goods for the satisfactionof basic needs.

The changing pattern of Indian economy has substantially influenced the structure of foreign trade of the country. Imports of cereals in 1963-64 and 1964-65 were at a higher level because of somewhat lower domestic crop. The increasing production coupled with drastic cuts in the import of raw cotton and transport equipment reduced to some extent our dependence on imports. Formerly copper and lead ores and concentrates were exported while today they are replaced by refined lead, electrolytic copper rolled and wrought sheets, wires cables etc. Instead of iron ore India today exports different kinds of machinery, structural steel constructions, electrical goods etc. The export of timber logs has fully given place to sawn timber, hardboard, plywood, veneers, furniture and paper in the exports. Production of chemicals, matches, explosives, leather, textile, glass, earthenware, ceramics and other industries show increasing export surpluses and is appearing in the World market in greater quantities. The Indian industry is today able to produce complete industrial plants, power station, equipment for mines etc.

The change in the structure of the foreign trade is accompanied by alterations in its directions as well. Previously India with her agricultural products, minerals and other raw materials was bound exclu-

sively to the foreign market. Today her products are exported to foreign countries. The import trade, however, is still restricted to a smaller number of countries. Apart from the industrial goods, India is an exporter of raw materials such as cotton, wool, rubber, jute rice, coffee, cocoa-beans, spice and fruits etc.

The changing pattern of the Indian industries has substantially been influenced by the chemical industry of the country. "Old industries have grown, new industries have been started, new plants laid, and new technical skill built up. The iron and steel industry has taken up several new and difficult lines of production, and has made a success of them. The establishment of new industries like aluminium and various chemicals, both heavy and fine, has also added greatly to India's economic strength. The manufacture of machine tools has been firmly established, and the engineering industry has been greatly enlarged. India's natural resources in regard to not only metals and minerals, but fibres, wood, leather, vegetable oils, paints and rubber, have been tapped for building up new basic industries. In the result, our basic industries have also expanded, new basic industries have been planted and India's industrial structure has been greatly enlarged. We were thus put on the road to a broad-based industrial development which may soon rectify the lopsidedness that has long characterized Indian manufacturing industry."

QUESTIONS

1. Estimate the potentialities of India for the development of large-scale manufacturing industries so far as such development is dependent upon geographical conditions.

2. Taking into consideration the economic resources and geographical conditions of India, discuss the possibility of its development into a first-rate industrial country. Examine from the geographical point of view some large-scale industrial enterprises under the consideration of the Government of India.

3. Write an essay on the changing pattern of Indian Industries.

CHAPTER 23
Metallurgical Industries

Metallurgy was little developed in India before independence. The earliest attempt at the manufacture of iron and steel by modern methods, made in 1830 in South Arcot, failed. In 1874 the Barakar Iron Works started work on the Jharia Coalfields; the Works were acquired by the Bengal Iron and Steel Company in 1889. Production amounted to 35,600 tons in 1900. The Tata Iron and Steel Company, established by the late Jamshedji Tata in 1907 at Sakchi, Bihar, first produced pig iron in 1911 and Steel in 1913. The two other important manufactures were the Indian Iron and Steel Company (formed in 1908 at Hirapur near Asansol,Bengal) and the Mysore State Iron Works (now Mysore Iron and Steel Ltd.), started at Bhadravati in 1923. By 1939, the production of steel and pig iron was over 8 lakh and 18 lakh tons respectively. World War II gave an impetus to the industry.

After independence wide vistas of development opened up before the Indian industry. During the First Five Year Plan, in addition to preparatory work for putting into operation old plants, restored after the second World War, work was being carried out on the fundamental reconstruction of the old plants. Blast furnaces were improved (hearths were widened), methods of charging with raw materials and fuel were perfected (mechanized inclined skip hoists were installed), the capacity of open-hearth furnaces was increased, rolling mills were equipped with more powerful drives, and heating furnaces were reconstructed. The output of pig iron and steel in India grew from year to year.

During the first two Five Year Plans, a powerful Indian iron and steel industry, equipped with modern machines and techniques, was practically created anew. We not only achieved a considerable increase in the production of ferrous metals, but also created new branches of metallurgy that have brought about qualitative changes in the structure of Indian metallurgy. The production of special grades of steel that had not been produced in India at all, increased sharply. Electro-metallurgy, which could satisfy the demands of machine-building plants in special grades of steel: heat resistant, acid resistant, high-speed, magnetic, electrical *etc.*, was created anew. Naturally the rapid growth of the iron and steel industry of India exerted a decisive influence on the associated branches of industry. On the basis of the newly-developed

metallurgical industry it became possible to organize the production of automobiles, tractors, aeroplanes, chemical equipment, power installations, precision instruments tools.

Further improvement in production technology featured better preparation of raw materials and fuel (coke) in blast furnace production, the use of oxygen in steel production, the development of periodic and economic cross sections of rolled stock. Wide scale mechanization of laborious work and the automatization of production process has been achieved.

One of the most important problems facing Indian metallurgy is the development and introduction of new technology in steel-smelting production, and the development of continuous process coasting.

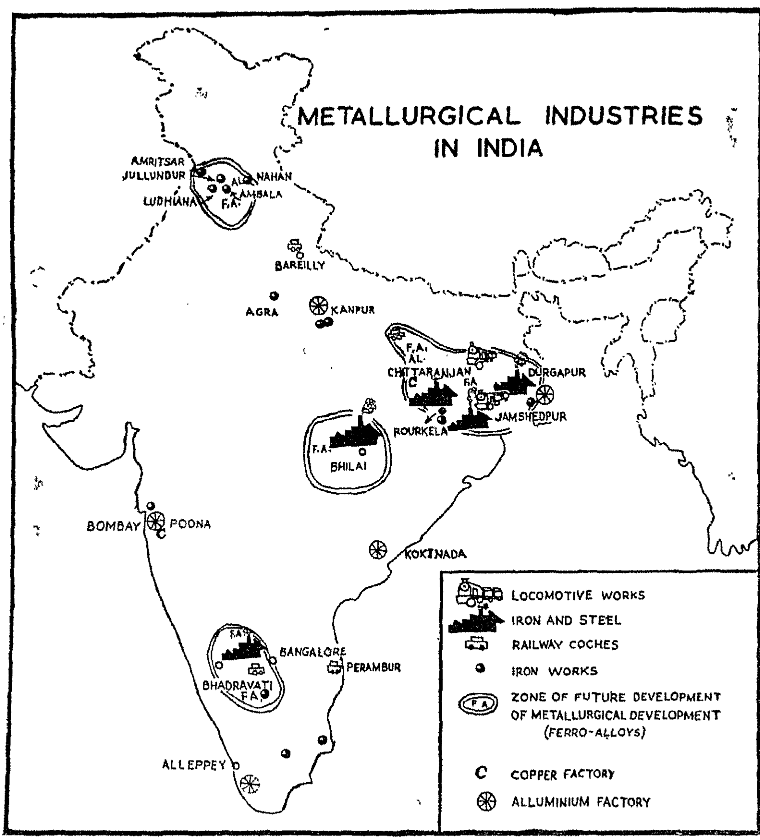


Fig. 55. Metallurgical industries in India.

A wider use of oxygen for sharp intensification of a number of important metallurgical processes is planned. Indian metallographists are conducting extensive work in developing new grades of steel and alloys, possessing a wide variety of mechanical, heat resistant, corrosion-resistant, and other properties. Figure 55 shows the metallurgical industries in India.

Iron and Steel is the important metallurgical industry in India.

IRON AND STEEL INDUSTRY

The iron and steel industry is the basic industry of the modern world. But the art of manufacturing iron was known to India at least one thousand years before Christ. The iron pillar at Delhi is a standing proof of the quality of iron produced in India in ancient times. The famous Damascus blades of the Saracens were made of the Indian material. In modern times, the first attempt at steel making in India was made by an I. C. S. officer, named Joshiah Heath. His scheme failed. It was the Barakar Iron Company, which later passed into the hands of the Bengal Iron Company, that first succeeded in this object.

But it was only when the Tata Iron and Steel Company took up this work that steel production was started in India. The original project of the Tatas was to make 1,20,000 tons of pig-iron and 70,000 tons of steel per year. The growth of the Tatas has, however, been remarkable. The Company's works at Jamshedpur are expanding to be able to produce much larger quantities of pig-iron and steel. This increased production by the Tatas together with the production of the Indian and Iron Steel Company of Bengal and of the Mysore Steel Works is expected to meet the normal demand in India.

The most important factors in the development of the modern iron and steel industry are :—

(a) Raw materials, (b) fuel and (c) market. The other factors like communication, skilled labour and locational advantages are of minor importance.

While considering the development of the iron and steel industry in India, the first thing that strikes us is the lack of adequate market. The products of this industry are in demand mostly by industrialized urban societies. Machinery and tools for the factories, rails, wagons and cars for communications, steel girders and door frames for buildings, and thousand and one such things of steel are in demand by urban societies today. India is backward industrially. She has very few towns; she has very few railways; she has very few cars. The natural result is that she has very little of iron and steel industry.

The other thing that strikes us is India's poverty in coal. Coal is the only important fuel that is used in the iron and steel industry today.

Electric furnaces are in use in some countries like Sweden, Switzerland and the U.S.A. But their output is negligible; besides they handle only a special type of iron-ore. India's lack of suitable coal for iron and steel manufacture is, therefore, her greatest drawback in developing this industry.

As good coal is indispensable for iron and steel manufacture, we notice that practically the whole of this industry in India is centred near the coal-fields of Jharia. The supplies of iron-ore are widespread over the Peninsula, but they are seldom utilized, as they are not easily accesible to coal.

But while India is poor in suitable coal and has little market for iron and steel goods, she has immense supplies of good quality iron-ore. It should be possible to take this ore to places where coal is easily available to smelt it. This can be taken to places on the coast where iron and steel works can be started with the help of imported coal. This is being done by Brazil, which is importing coal for the purpose from U.S.A. But the market for steel must be enlarged first. It is also believed that the new Knipp-Renn process of steel manufacture enables the use of inferior coals in smelting iron-ore. The pig-iron produced by this process is later refined with the help of electricity which can again be made from inferior coal. With this process India can make the cheapest steel in the world. About two-thirds of the cost of steel-making is on account of raw materials. India uses a very rich iron-ore containing 60% to 69% of metal in it. In Europe and in America most of the ore used is poorer in metal (40% in Europe and 50% in U.S.A.). Indian iron-ore is a very low phosphoric ore, having only about $\frac{1}{4}$ % of phosphorus. The European ores contain $1\frac{1}{4}$% of phosphorus and, therefore, are costlier to refine. The coal used in India for smelting is practically free from sulphur. This is not the case in Europe and America. The labour charges in India are much lower than in Europe or America. India also possesses immense quantities of good quality iron-ore. In Singhbhum district it is estimated that there are 1000 crore tons of such high grade ore. At the present rate of consumption this ore should last for about 2000 years.

The following table gives the annual per head consumption :—

U.S.A.	1,237 lbs.
U.K.	628 ,,
Australia	480 ,,
U.S.S.R.	240 ,,
France	322 ,,
Belgium	501 ,,
India	12 ,,

The present iron-manufacturing centres in India can be divided into two classes :—

(1) The pig-iron and steel manufacturing centres; and

(2) The pig-iron manufacturing centres.

Steel manufacturing requires proportionately more iron-ore than coal, while pig-iron requires, proportionately more coal than iron-ore. The Indian Tariff Board of 1924 calculated that for manufacturing 1 ton of pig-iron $1\frac{3}{4}$ tons of iron-ore and 12 tons of coking coal are required in India; while for 1 ton of finished steel, 2 tons of ore and $1\frac{5}{8}$ tons of coking coal are required.

The biggest iron and steel works in India, the Tata Iron and Steel Works at Jamshedpur are, therefore, situated nearer to the iron-ore supplies than to coal supplies.[1] The smelting works at Kulti, Burnpur and Dhanbad—producing mostly pig-iron—are situated, on the other hand, nearer to coal and iron-ore.

According to the 1958 Census of Indian Manufactures, there were 167 large and small iron and steel works in India, in which about Rs. 183 crores of capital was invested and 93,283 persons were employed.

There are at present four main producers of iron and steel, *viz.* :—

(i) The Tata Iron and Steel Co., Jamshedpur.
(ii) The Indian Iron & Steel Co.
(iii) Mysore Iron & Steel Works, Bhadravati.
(iv) Hindustan Steel Limited at Drug, Bhilai and Rourkela.

The total capacity for pig-iron and finished steel is estimated to be 27,71,000 tons and 17,30,000 tons per annum respectively. The industry is mainly concentrated in Bihar and West Bengal.

1. Tata Iron & Steel Company

Historical Background. The Tata Iron and Steel works its existence to the vision of Jamsetji Nusserwanji Tata, who was one of the founders of Steel in modern India. Over sixty years ago, Jamsetji realised that the country's freedom from poverty and ignorance lay in industrialization, the three basic ingredients of which were knowledge, power and steel. And Jamsetji gave India her first research institute, the Indian Institute of Science at Bangalore, her first power generating system, The Tata Hydro-electric projects, which account for nearly one-sixth of the total electric power generated in India even today; and her modern steel industry, the Tata Iron and Steel Company's works at Jamshedpur.

Tata Steel's efforts helped India not only to take the first steps towards industrialization, but also to lay the basis for the future develop-

1. The Tatas use annually about 20 lakh tons iron-ore of which Noamundi supplies about one-half; Gurumashisani, Badampahar and Sulaipat supplying the rest. They use annually 25 lakh tons of coal of which Jharia supplies about 15 lakhs, Manganese comes from Bara Jamda, Jharia supplies about 15 lakhs. Manganese comes from Bara Jamda, and limstone from Birmitrapur, Hathibari and Baradaur They use about 6 lakh tons of limestone annually- Dolomite comes from Pagposh and Fireclay from Belapahar.

ment of India's steel industry. In December 1911, the 100,000 ton plant produced its first coast of iron and rolled its first steel ingot in February 1912. The plant attained capacity production by 1916 to meet war demands.

Situation. The site of the Jameshedpur Works has been selected in a narrow valley formed by the river Subarnarekha and the Khorkai (shown by R. in the map 55) rivers in the district of Singhbum in Bihar. The valley is only about four kilometres broad where the works are situated between the two rivers. The sketch map shows that this is the only-fairly extensive, flat and low-land area available in the vicinity of the hills that extend miles around. Iron works require large areas of flat land for their operation. This valley is, therefore, an advantage to the Jamshedpur Works. The hills to the south of this valley are the source of the coveted iron ore deposits of Orissa.

Raw Minerals and Source of Power. The main source of iron-ore supply of the Jamshedpur Works lies in these hills within 96 kilometres. The coal supplies come from the Jharia coalfields at an average distance of about 160 kilometres.

Water. The two rivers, the Subarnarekha and the Khorkai supply the Works with water. The water requirements in the iron works are very large. The presence of these rivers is, therefore, a great advantage enjoyed by Jamshedpur. These rivers are irregular in flow and almost dry up during summer. The water is, therefore, pumped from the Khorkai, which is nearer the Works, and stored in a tank. The bed of the Khorkai also supplies sand which is used in making moulds for pig-iron. The Works are served by the main line of the E. Ry., joining the two most important towns of India—Bombay and Calcutta which provide the biggest markets for Tatas' products. The iron-ore and coal supplies are brought to the Works by the branch lines of this railway.

Limestone. The only important raw material which comes from longer distances is the flux (limestone or dolomite). Unfortunately, most of the larger occurrences of good limestone lie at distances above 320 kilometres from the Jamshedpur Works. The limestones found nearby are inferior, and irregular in quality of the material. Recently a large deposit of rich dolomite has been discovered near Sulai, a village situated a few miles from Dhatura station on the line of the E. Railway near Jharsugudha in Orissa. A great importance attaches to this discovery in view of the easy communication both with Tatanagar and Burnpur. The Jamshedpur Works first got their supply of lime stone from Katni near Jabalpur, but now they operate their own quarries at Pagposh, in Gangpur, which produces a dolomatic limestone which is inferior to the true limestone.

Manganese etc. The other raw materials, manganese ore, fire clay and chemicals are required only in small quantities, and are available near at hand.

Labour force. The Jamshedpur Works are situated in a region that is infertile and very thinly populated. The inhabitants of the region are the backward Santhal tribes who do not care to work in factories. The labour force is, therefore, recruited from the densely populated valley of the Ganga mostly Bihar, U.P. and M.P. The skilled labour is now mostly Indian and only partially foreign.

The Tata Iron and Steel Company has developed plans for the modernization and expansion of its Steel Works at Jamshedpur. The normal capacity of the plant at present is about 20 lakh tons of steel ingots (15 lakh tons of finished steel) per annum.

Establishment of an uptodate plant for the manufacture of refractories required by the steel industry and a plant for the utilization of blast furnace slag in the manufacture of light weight aggregate and hollow blocks has been completed. It is understood that the firebrick plant will meet most of the requirements of the Steel Works in the way of refractories and as the plant is equipped with the most modern machinery for efficient and large-scale production employing the latest labour-saving devices, it is expected that this new ancillary unit will be of very great help not only in reducing the cost of steel but would also make the Tata Iron and Steel Works rely on its own resources for this important raw material. The Steel Company has already vast resources of suitable raw material for the fire-brick plant.

Efficient utilization of industrial wastes, such as blast furnace slag has received considerable attention of the Steel Company. Economic utilization of the slag has been studied over a number of years and the proposal now made to manufacture light weight aggregate and hollow blocks would go a long way to ease the situation for the supply of a building material that is light, cheap and has better heat insulation properties.

Production. A modernisation and expansion programme was launched in 1951 to rehabilitate plant facilities and to raise the annual output to 1.3 million tons of steel ingots. Into this was dovetailed, in 1956, a further expansion programme to raise output to 2 million tons of ingots per year and completed early in 1959. The plant now consists of five batteries of coke ovens; six blast furnaces; three steel melting shops, two blooming mills and other finishing mills, including a wheel, tyre and axle plant.

Fourth Plan Expansion. As part of the programme of development of the Steel industry in the country during the Fourth Five Year Plan, the Tata Iron and Steel Company agreed in principle in 1963, at the instance of the Government of India, to undertake an expansion of capacity of an additional million ingot tons. Later, Government requested TISCO to consider an expansion scheme of the Jamshedpur works by two million tons of ingots in the Fifth Plan to bring down

the capital cost per ton of ingot steel. During the Fourth Plan TISCO is likely to expand production to 30 lakh tons of ingot steel.

2. Indian Iron & Steel Company

Under the Steel Companies Amalgamation Act (1952) the Indian Iron and Steel Co. has been amalgamated with the Steel Corporation of Bengal and the new company has been named the Indian Iron and Steel Company.

Site. The important pig-iron manufacturing centres of Kulti and Burnpur are situated on the coal-fields. They are in a thickly populated area where the network of railways joins them to Calcutta which is the largest iron market in India. The exports of pig-iron manufactured by these centres also go via the port of Calcutta.

Power. The iron works at Kulti, on the Barakar river, a tributary of the Damodar river, are the oldest existing iron works in India. The site of the works was originally chosen on account of the proximity of both coal and iron-ore. The out-crop of the iron-stone shales, between the coal-bearing BARAKAR and RANIGANJ rock stretches east and west from the Works, and for many years the clay nodules of this iron-stone constituted the only supply of ore used at these Works. Now, the richer ore from the deposits in Kolhan has taken the place of iron-stone shales.

The coal supply is obtained from the Ramnagar Collieries only 3 kilometres from Kulti, and from the adjoining collieries of Noonodih and Jitpur in the Jharia field. The limestone is obtained from Bisra (Gangpur), and also from Paraghat and Baraduar on the N. E. Rly.

Transportation

The Burnpur Works are situated in the triangle made by the N. E. Rly. and the E. Rly. near Asansol. The works are only 132 miles (211 kms.) away from Calcutta. The ore supplies come from Gua, in Kolhan. There is a branch railway line to Gua. Coal is obtained locally. Water supplies are obtained from a large reservoir on the works into which it is pumped from the Damodar river which is $2\frac{1}{2}$ miles (4 kms.) away.

Raw materials. Iron ore supply for IISCo comes from Bihar and is connected by E. Railway. Limestone as a flux is used in blast furnace and comes from Gangpur and Paraglas mines of Bihar.

Recently iron smelting has been started at Belur near Calcutta also.

In 1961 IISCO produced 2,67,873 tonnes and 5,63,054 tonnes of sale-able pig-iron and finished steel respectively and in 1962 the production of respective items were 2,04,298 and 6,13,720 tonnes.

Production. The IISCO Scheme of increasing production from 10 lakh to 13 lakh tons of ingots has also been approved and the company is negotiating with the World Bank for a foreign exchange loan.

3. Mysore Iron and Steel Works

Site. A distant iron-smelting centre is far away in Mysore where no coal is found. Charcoal, therefore, makes up the shortage of coal. It is obtained from the rich forests of Mysore for smelting iron-ore. This is the only large centre in India using charcoal in place of coal.

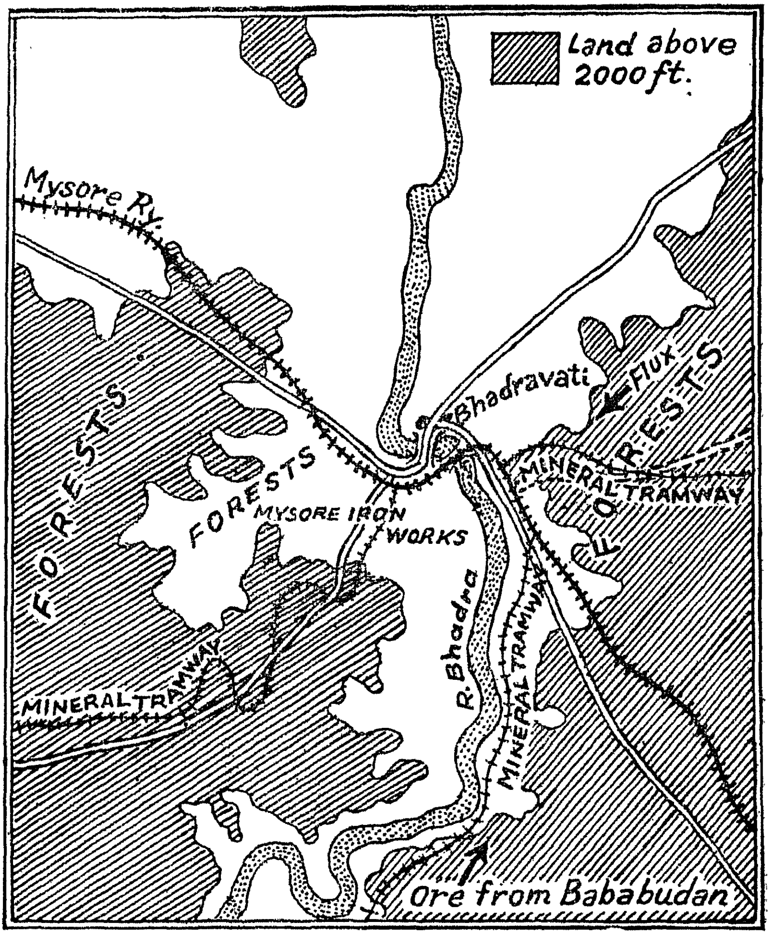


Fig. 56. Site of Bhadrawati Works.

The works are located at Bhadravati on the Birur-Shimoga branch line of the Southern Railway, about 11 miles (17.6 kms.) east of Shimoga. The site has been selected on the west bank of the river Bhadra where its valley widens to about 8 miles (12.8 kms.). Immediately in the neighbourhood are large reserves of forest.

Sources of Raw Materials. The raw materials are transported to the works by tramways and the Birur-Shimoga meter-gauge railway. The ore comes from Kemmangundi on the top of the Bababudan hills, about 26 miles (41.6 kms.). south of Bhadravati. It was first proposed to bring the dolomite flux from Tumkur district but the cost of transport being heavy, the proposal was given up. Limestone is now used as flux and is obtained from Bhandigudda near Gangpur 13 miles (21 kms.) east of Bhadravati. The Bababudan hill ores need mixing with siliceous ores. These ores are obtained from a quarry opened up near Birur. The wood required for making charcoal by distillation comes entirely from the jungle trees which cannot be made use of for any better purpose. The Bhadravati works are better suitated in respect of ore and flux supplies than any other large iron-smelting centre in India. The ore used is, however, inferior.

Production. Apart from the major production of pig-iron or steel in the iron works, the works also produce a large quantity of chemical by-products from coke. Coaltar and ammonium sulphate are the important by-products in the works where coke is used for smelting, *i.e.*, in Tatanagar and Kulti, etc., while lime acetate, wood, alcohol and woodtar are the by-products at Bhadravati where charcoal is used. The manufacture of cement is another industry started recently at Bhadravati to make use of some of the by-products of the iron works, especially slag.

NEW STEEL PROJECTS

Even in the First Five Year Plan, with its major emphasis on agriculture, provision was made for the stepping up of the annual steel output from a million tons in 1950 to a target capacity of 1.65 million tons. In December, 1953 the Government of India concluded an agreement with the well-known German combine of Krupp-Demag for establishing a half million ton plant at Rourkela in Orissa. This was to be the first of a series of such agreements for foreign collaboration in the expansion of India's Steel industry—with the Soviet Union for the establishent of a Second new plant at Bhilai in Madhya Pradesh; with the World Bank for the expansion of capacity of the Tata's plant at Jamshedpur; and with a consortium of British firms for the establishment of the third new plant at Durgapur.

Rourkela Steel Plant

Amidst the picturesque hill scenery of Chhotanagpur, at Rourkela—some 412 kilometres away from Calcutta on the main railway line to Bombay—a modern township of steel has been established.

Raw materials and transport

Among the various materials required in Steel making, the more important are Iron ore, coal, manganese ore and limestone.

Iron Ore. The vast bulk of iron ore supply for the Rourkela plant comes from mines of Barsua and Gua.

Coal. Coal for the plant comes from Kargali, Bokaro and Jharia fields. Steel production demands high grade coals of which India, like many other countries, possesses only limited reserves.

Lime Stone. Limestone comes mostly from the Purnapani area.

Water Supply. An abundant supply of water is a necessary prerequisite for any steel producing unit. A broad idea of this requirement can be had from the fact that, at Rourkela, nearly 25 million gallons of water a day is needed for cooling purposes and for the scrubbing of gases alone.

Transport. Rourkela enjoys a favourable location in respect of railways and roads. Rourkela is connected with Calcutta and Bombay which are two extreme points of the main railway line. To meet the demands of Rourkela, a number of new railway lines are being laid in the coal and iron regions. A 64 kilometres branch railway line is being laid between Rourkela and Dumaro for transporting iron ore.

Production. The first blast furnace of the one-million ton plant was inaugurated in February 1959. The plant which has been the first unit to produce steel in the public sector, producs steel by L. D. process. This process, it is claimed, has the advantage of lower capital and operating costs, higher rate of production and saving in space and ancillary equipment. It also releases by-products for the manufacture of fertilizers and a series of important chemicals.

The tonnage oxygen plant is a key unit of the integrated steel works at Rourkela and is to supply low cost pure oxygen for the manufacture and is to supply low cost pure oxygen for the manufacture by the oxygen blowing L.D. process of the three fourths of the million ton ingot steel annually. The tonnage oxygen plant which is the biggest of its kind in Indian Republic consists of three units each designed to produce 100 tons of oxygen of 99.5 percent purity and about 160 tons of pure nitrogen of 99.99 percent purity per day. Provision is there to produce liquid oxygen to be utilized in ore mines for blasting purposes.

The first unit of the oxygen plant which was commissioned in December 1959, has so far produced about 14,000 tons of oxygen of average purity of 99.5 percent with the second air separation unit the production of oxygen at Rourkela is about 200 tons per day. The oxygen is supplied to L.D. steel plant open hearth furnaces and blast furnaces etc. through pipelines.

The plant is also equipped for recovery of crude benzol, coaltar and ammonia from which a variety of chemical products can be manufactured.

Besides the above, the following new items were added—

(i) The biggest Steel rolling mills in Asia involving approximately 10.8 lakh tons of steel has been completed at the Rourkela Steel Project.

(ii) The pipe plant being set up for the production of steel pipes, by the electric resistance welded process at Rourkela produced 8,600 to 31,000 tons per month depending upon the size and specifications of pipes 8.3/4 in. to 20 inches.

Production in 1965 included 10.7 lakh tons of iron and 10.8 lakh tons of steel ingots. The fertilizer plant put up as an adjunct to the steel plant was also commissioned in November, 1962 and produced 1.90 lakh tons of calcium ammonium nitrate during 1965. The annual capacity of the Rourkela plant is being expanded to 18 lakh tons of ingots which will be rolled into 12 lakh tons of finished steel. Its further expansion to 25-35 lakh tons is under consideration.

Bhilai Steel Project

Bhilai Iron and Steel Works, a Government of India enterprize, has been established with Russian help. The Russian Government has provided scructural machines and equipments as well as technical assistance for the construction and working of the plant. The work of erecting the plant started in early 1957 and the plant has been almost completed and is in full production. It is in a position to produce annually 14.9 lakh tons of steel and it is estimated that later on the production will go upto 25 lakh tons.

Location. Bhilai Iron and Steel Plant has been established near Bhilai, a small village in the Durg district of Madhya Pradesh. Extensive level land with hard soil of Bhilai area is the most suitable site for the erection of the plant.

Raw materials. For steel making the most important raw materials are Iron Ore, Coal, Manganese and Limestone.

Iron Ore. Iron ore supply for the Bhilai plant comes from Dhalli Rajhara hills which lie at a distance of about 96 kilometres south of

Bhilai and is connected by a newly built railway. The iron ore deposits of this hill contain not less than 65% of iron.

Power. The coal supply for the plant, however, is not very favourable and the fields of good coking coal of Jharia and Bokaro and 76^0 kilometres from Bhilai. But these fields under transport facility supply coal to Bombay. They can well supply coal to Bhilai plant also, which is on the main railway line between Jharia coal fields and Bombay. Other important coal fields are Kargali, Bokaro and Korba.

Limestone. Limestone as a flux is used in blast furnace and open hearth operation comes from Nandini mines which are hardly 25 kilometres north of Bhilai. A railway line is running from Bhilai to the mines.

Manganese ore as a raw material for the plant comes from Balaghat area which is about 160 kilometres by railway from the Bhilai plant.

Water. The question of water supply is important to be taken up for consideration in case of steel plant since it is required both for the plant and for the township. The two tanks, Maroda Tank I was in existence before the establishment of the plant and Maroda Tank II was constructed after the construction of plant to supply water. These tanks are connected by Tandula main canal which takes its source from the water head of Tandula river which supplies water to the tank throughout the year.

Transportation. Bhilai enjoys a favourable location in respect of railways and roads. Bhilai is connected with Calcutta and Bombay which are two extreme points of the main railway line. Some railway lines have been recently constructed to serve the plant for hauling raw materials which are required for the plant.

Production. From the time the first units of the plant were commissioned to the end of January 1961, the Bhilai works has produced 1,148,000 tons of coke, 1,055,000 tons of pig iron, 398,000 tons of steel, 327,000 tons of merchant steel, 2,081,000 tons of iron ore and 746,000 tons of limestone.

Iron is converted into steel by the conventional open hearth process in six furnaces of 250 tons capacity each. The rolling mills consist of one blooming mill, one continuous billet mill, one rail and structural mill and one merchant mill. These will convert one million tons of ingots into the following products :

Rails, standard gauge.	..	100,000
Rails, narrow gauge.	..	10,000
Railway sleeper bars	..	90,000

Standard and broad flanged, channels, angles and other light and heavy structural sections (beams with section height upto 24″) ..	284,000
Rounds from 7/8″ to 3″ dia. & squares with sides 7/8″ to 3″ ..	121,000
Flats from 2″ to 5″ wide ..	15,000
	620,000
Billets for re-rolling at outside rolling mills from 2″ × 2″ to 3″ × 3″ cross section. ..	150,000
	770,000
Pig-Iron ..	300,000

The plant has already exceeded the rated capacity in the production of pig-iron, steel ingots and finished steel. During 1962-63, the first financial year of the whole plant in operation, the production of pig-iron and steel ingots which was 11.7 and 10.6 lakh tons was 105 and 106 percent of the rated capacity. A contract has been signed between the Hindustan Steel Ltd., and Russian Organisation 'Tyazhpromexport' in February 1962, according to which the capacity of the plant is to be expanded to 25 lakh tons of steel ingots per annum which will be rolled into 19.5 lakh tons of finished steel.

Under the extensive programme, a coke oven battery, a blast furnace, an open hearth furnace and the slag granulation plant were commissioned in 1964. Eight more units were commissioned during 1965; the later of the remaining units is expected to be commissioned during 1967. The plant is to be expanded further to 35 lakh tons; the U.S.S.R. Government has already committed the necessary assistance under a contract signed in August 1965. The first step for this expansion has been taken with Bhilai going in for the sixth blast furnace which would provide enough iron to sustain a production of 40 lakh tons of steel.

Durgapur Steel Plant

One of the main projects built with British aid is the Durgapur Iron and Steel Works. The construction of this works has created the prerequisites for the establishment of a powerful metallurgical industry.

Site. Apart from the availability of raw materials near at hand, the climate of the Durgapur area is congenial and unlike the Calcutta area, the land here, with high bearing pressure, is suitable for building heavy industrial units.

From the standpoint of siting a metallurgical industry and industries based on coal carbonization there are very few sites in India which

can give more satisfactory answers to the majority of the points raised above regarding selection of site than Durgapur.

Raw Materials. If we look at the mineral map 58, we find that near Durgapur high grade coking coal can be had in the neighbouring coal-fields of Raniganj and Jharia. Although high grade iron ore occurs in many parts of India, particularly Madhya Pradesh and Orissa, it is only round about Durgapur, in the D. V. C. region, that large deposits of iron ore are found in close proximity to coking coal. There is no element of uncertainty or speculation regarding the quality or quantity of iron ore deposits of the Sighbhum iron belt and the coking coal deposits of the neighbouring fields of Raniganj and Jharia.

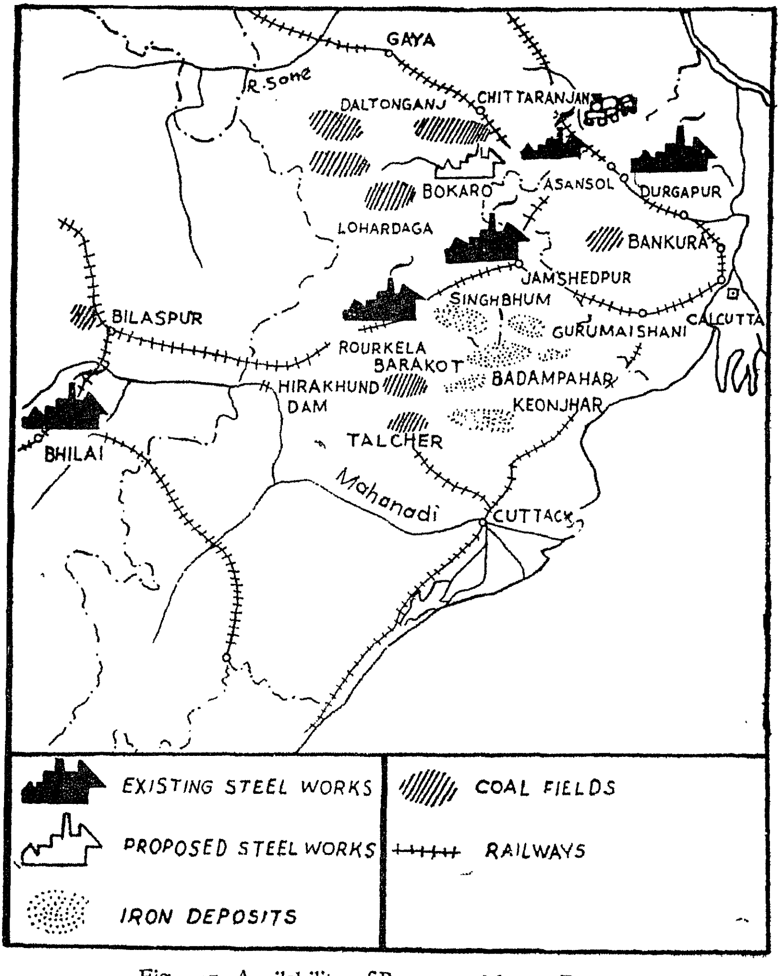


Fig. 57 Availability of Raw materials near Durgapur;

Transportation. The transport facilities are excellent, as there is an electrified four-track railway system, a major highway and an all weathering navigation canal linking this producing area with the consuming centres and the port of Calcutta. Produce from this area easily reached the biggest consuming centre around Calcutta at a transport cost lower than from any plant located in Bihar, Orissa or Madhya Pradesh—Durgapur being nearer Calcutta, only about 160 kilometres by rail.

Production. The first blast furnace at Durgapur was inaugurated in December 1959, with a capacity of 1,000,000 ingot tons steel. The economic importance of the Durgapur Steel Plant does not lie solely in its production of steel. It also produces a wide variety of by-products which include crude tar, ammonium sulphate, crude benzol, benzene, toluene, pitch creosote, road-tar and anthracene oil. The table below shows the by products of Durgapur plant per day.

TABLE : CXXVII *Showing the by-products of Durgapur Plant per day*

Gas	60 million Cu. ft.
Ammonium Sulphate	57 tons
Crude tar	156 tons
Benzene	6240 Gal.
Toluene	884 Gal.
Xylene	182 Gal.
Solvent Naphtha	142 Gal.

The Durgapur plant was completed in 1962 and almost all its units have achieved the rated capacity of production. During 1965, the plant produced 12.67 lakh tons of pig iron against the annual rated capacity of 12.84 lakh tons, and 10.7 lakh tons of steel ingots. The Third Plan programme was to expand the plant to 16 lakh ingot tons capacity to yield 12 lakh tons of saleable finished steel and semis in addition to 3 lakh tons of pig iron for sale. The expansion work is expected to be completed by the end of 1966. Further expansion to 34 lakh ingot tons is proposed for the Fourth Plan.

Bokaro Steel Plant

Another steel plant is being set up at Bokaro with technical and financial collaboration of the U.S.S.R. under an agreement concluded in January 1965. The plant will produce sheet, hot and cold rolled strip and galvanised sheet. Provision has also been made for producing 8.80 lakh tons, annually of foundry grade iron.

The annual production of finished steel in three different plants of India are shown in the following table.

TABLE CXXVIII : *Production of three Plants in India*

	Rourkela	Bhilai	Durgapur
		(Figures in tons)	
Hot-rolled sheets and Strips	300,000	..	..
Cold-rolled Sheets and Strips	170,000	..	..
Heavy plates	200,000	..	..
Tinplate	50,000	..	..
Structural Sections	..	284,000	..
Flats, rounds and Squares	..	136,000	..
Rails	..	110,000	..
Sleeper bars	..	90,000	60,000
Billets for re-rolling	..	150,000	150,000
Heavy forging blooms	..	..	10,000
Forging blooms	..	..	60,000
Merchant bar sections	..	..	240,000
Light and medium sections	..	..	200,000
Wheels, tyres and axles	..		50,000
Pig Iron*	10.7	14.9	12.67
Steel ingots*	10.8	12.7	10.7

The developments of the Steel industry in the public sector during the Fourth Plan comprise the expansions of Bhilai, Durgapur and Rourkela steel plants and of the Mysore Iron and Steel Works as also the establishment of a new steel plant at Bokaro. The levels of development visualised under these public sector programmes are given below:

	Scheme	Steel ingots	Free pig iron lakh tons
(a)	Expansion of :—		
	Bhilai	40	—
	Durgapur	16	3
	Rourkela	25-35	18
(b)	Mysore Iron and Steel	—	24
(c)	Bokaro Steel Plant	—	8.8

Side by side with the formation of new plants for the production of 4532 thousand tons of steel per year, the existing main producers, namely the Tata Iron and Steel Co., Ltd., have also embarked upon

*Figures in lakh tons, 1965.

large scale expansion programme. The programme of expansion of the TISCO envisages increase in production in the first stage from 15 lakh tons to 8 lakh tons of finished steel. In the next phase, the production will be raised to 20 lakh tons of ingots and 15 lakh tons of finished steel.

The Indian Iron and Steel Co., Ltd., has programmed for an expansion of 13 lakh tons of finished steel. The Mysore Iron and Steel works has also planned to increase its production from 100,000 tons to 24 lakh tons.

India's Production of Steel

India's production of pig-iron and steel is insignificant when compared with that of the leading industrial countries of the world. It gives us a great shock, however, to know that we produce even less than either Italy, Poland, Canada, Sweden Austria or Hungary—all countries where, as in our case, agriculture is the dominant occupation.

The following table gives the production of pig iron and ferro-alloys and crude steel in some important countries of the world as compared with India.

TABLE CXXIX : *Production of Pig Iron and Crude Steel*

Countries	Pig Iron and Ferro alloys (000 Metric tons)	Crude Steel (000 Metric tons)
India	2,145	1,842
U.S.A.	53,403	77,342
U.S.S.R.	39,600	54,871
Fed Rep. of Germany	16,755	22,785
U.K.	13,183	19,879
France	12,142	14,607
China	9,500	8,000
Japan	7,691	12,118

Due to lack of market in India, prior to independence, smelting industry had become the source of exporting our iron ore to foreign countries in the form of pig iron. By this method foreign countries were able to get from India the metal without impurities contained in the iron ore. Iron-ore is a heavy and bulky material whose export to distant countries is not economical if exported as ore. If, however, it is exported as bricks of pig iron, the cost of transport is negligible. England and America could thus purchase pig iron from us and send it back to us as finished steel or machines at a much higher price.

Although the United States of America is one of the world's largest producers of pig iron, she imports considerable quantities from India because of the unusual characteristics of Indian pig iron which

gives it special value in the manufacture of steel. Pig Iron is mixed with scrap steel in the open hearth furnaces to make steel. The more scrap steel which can be used with the pig iron, the less expensive and more desirable will the resulting steel be. Indian pig iron is a good scrap carrier, *i.e.*, it makes possible the use of a greater amount of scrap, and because of this, American steel producers are willing to pay higher price for Indian pig-iron than for American pig iron.

The year 1965 was an important year in India's steel economy. It was the first year in which production of iron and steel showed a large increase. With the expansion of existing steel works and establishment of new steel projects, production in 1965 was 4532 thousand tons against 1260 thousand tons in 1955. Production of saleable pig iron recorded a sharp increase from 1757 thousand tons 1955 to 6956 thousand tons 1965. The following table shows the production of Iron and steel in the year 1950 to 1966.

TABLE CXXX : *Iron and Steel Production in India*

Year	Pig Iron (000 tons)	Direct Casting (000 tons)	Ferro-alloys (000 tons)	Steel ingots and metals for casting (000 tons)	Semi-finished Steel (000 tons)	Finished Steel (000 tons)
1950-51	1,52.4	98.4	18.0	1,437.6	1,142.4	1,004.4
1951-52	1,708.8	92.4	24.0	1,500.0	1,249.2	1,076.4
1952-53	1,684.8	129.6	40.8	1,578.0	1,308.0	1,102.8
1953-54	1,654.8	115.2	7.2	1,507.2	1,230.0	1,023.6
1954-55	1,792.8	127.2	40.8	1,684.8	1,452.0	1,243.2
1955-56	1,756.8	126.0	12.0	1,704.0	1,465.8	1,260.0
1956-57	1,807.2	122.4	28.8	1,737.6	1,484.4	1,338.0
1957-58	1,789.2	112.8	9.6	1,713.8	1,440.0	1,346.4
1958-59	2,002.8	72.0	25.2	1,813.2	1,599.6	1,269.6
1959-60	2,994.0	44.4	21.6	2,443.6	2,220.0	1,736.4
1960-61	4100*	34	..	35 lakh tons	..	2.200*
1961-62	4980*	40	..	43 ,,	..	2810*
1962-63	5796*	44	..	54 ,,	..	3708*
1963-64	6603*	50	..	59 ,,	..	4257*
1964-65	6593*	55	..	61.4 ,,	..	4343*
1965-66	6956*	..	..			4532*

* Figures in thousand tons.

ALUMINIUM INDUSTRY

Importance of Aluminium Industry

Within the period of three or four decades, aluminium has come to the forefront as an important metal. On account of its remarkable properties such as lightness, high thermal and electrical conductivity and resistance to corrosion, the uses of aluminium are daily growing in number and importance. Its most important and largest use today is in the building of aircraft. It is also being used in the manufacture of domestic utensils, railway carriages, motor cars, furniture, storage receptacles for liquids, as powder or paste in the paint industry, for cables in electrical transmission lines. A large quantity is also being used for portable, semi-portable or prefabricated houses. It is because of these multifarious uses that the world production of aluminium which was merely 6,76,123 tons in 1939 has been rapidly increasing till it now reached the peak of about 30 lakh tons and the largest increase in production has taken place in the U.S.A. and Canada accounting for more than 55 p.c. of the world output.

History. In India the aluminium industry is a war-born industry. It has made spectacular developments during the past few years, and has now a prominent place among the world producers of aluminium. It is the only non-ferrous metal of which, so far as is known, India possesses large deposits. Known deposits of bauxite ore (aluminium ore) are estimated at 250 million tons of which about 40 million tons are of best quality. This amount should be enough for a very long time, at least 150 years. Rapid developments are taking place in the manufacture and utilization of this metal.

In America aluminium with various alloys has been used for almost every purpose including making of bridges and houses, ship-building, aircraft, etc.

Raw Materials. The important raw materials required to make a ton of aluminium are approximately as follows :—

Bauxite	4.5 tons
Petroleum coke	0.75 „
Pitch	0.2 „
Coal	4.0 „
Furnace oil	0.5 „
Caustic soda	0.16 to 0.2 „
Cryolite	0.07 to 0.10 „
Aluminium flouride	0.035 to 0.04 „
Fluospar	0.007 to 0.008 „
Electric energy	20,000 to 24,000 Kwh.

Regarding availability of raw materials, it can be said that we have about 250 million tons of all grades of bauxite reserves. Of this, high grade reserves amount to about 35 million tons, which can be regarded as sufficient for the industry with a capacity of 50,000 tons per annum for at least 150 years. Bauxite is available in abundance in Ranchi and Palamau districts of Bihar, Amarkantak and Bilaspur districts of M.P. But we are deficient in coal and electric power. Other raw materials are available only partly or not at all from indigenous sources. Caustic soda and soda ash are not produced in sufficient quantities. Fluospar occurs to some extent in M. P., cryolite, aluminium fluoride, carbon blocks are imported from abroad.

Producing centres

The year 1938 saw aluminium produced for the first time in India at the Alupuram (Kerala) Reduction Works of the Indian Aluminium Company. Since then spectacular developments have taken place. The whole of the war-time requirements were supplied by this company. Its rolling mills in Belur, near Calcutta, and the manufacturing plants produced sheet metal and components for aircraft parts, radio and field telephone equipment, range finders, field hospital equipment, *etc*. From technical point of view, production operations, in the Travancore factory compare favourably with the large production units in Canada and the United States of America. Carbon electrodes required for aluminium reduction are produced in the company's factory. Arrangements are complete for the production of strong alloys of the duralumin type.

In India at present there are two companies which produce primary aluminium. One company owned and operated by an Indian firm —the Aluminium Corporation of India (1937)—is located at Jaykaynagar near Asansol and is integrated plant which takes in bauxite and ends up with rolled metal and other finished products. The other company works in collaboration with Canadian company and has plants at different places—mining and alumina plant at Muri (in Bihar); Reduction and extrusion works at Alwaye in Kerala, and the Rolling mills at Belur (in West Bengal) and Powder and Paste plant at Kalwa (near Thana in Maharashtra).

The other Concerns which had come into the field are—(1) Aluminium Manufacturing Co. Ltd., Calcutta; (2) Wolverhampton Works Co. Ltd., Bombay; (3) Anant Shivaji Desai, Bombay; (4) Lallubhai Amichand, Bombay.

Production

Growth of the aluminium industry in India in past three decades has been phenomenal. Prior to World War II, India imported 2600 tons annually. During the war, the metal became well known becaue

of its demand for use in aircraft. In 1943, Indian production was 2000 tons and it has steadily increased to where planned capacity for 1966, is 54,000 tons.

The following table shows the actual production of aluminium in the country—

TABLE CXXXII : *Production of Aluminium*

Year	Production	
1948	3,362	tons
1949	3,490	,,
1950	3,696	,,
1951	3,848	,,
1952	3,566	,,
1953	3,758	,,
1954	4,886	,,
1955	7,225	,,
1957	7,771	,,
1958	8,182	,,
1959	7.4	(000 tons)
1960-61	18.3	,,
1961-62	19.9	,,
1962-63	42.6	,,
1963-64	54.0	,,
1964-65	54.1	,,
1965-66	56.9	,,

The following table shows the existing position of the two primary producers—

	Indian Aluminium Co. Ltd.	Aluminium Corp. of India Ltd.
Alumina	10,000 tons	6 000
Ingot	2,500 tons	1,500
Sheet & Circles	3,000 tons	500

A new factory for the production of aluminium cables for electrical transmission lines is under construction in Mirzapur. At the present moment there are only two primary producers in India namely the Indian Aluminium Company Ltd. (working in collaboration with the Aluminium Ltd. of Canada) and the Aluminium Corporation of India Ltd. Besides these two primary producers there is a flourishing

utensils and hollow ware industry in the country. In India the major aluminium producers, with capacities listed as at the end of the third and Fourth Plans, are :

(1) Establishment of a Smelter at Hirakud with an annual capacity of 10,000 tons.

(2) Expansion of mining of bauxite at Lohardaga to 80,000 tons and of alumina production at Muri in Bihar to 30,000 tons per annum by 1958.

Hindustan Aluminium Corporation Ltd., at Mirzapur in Uttar Pradesh.

Alwaye Reduction Works 5000 tons per annum. Koyna Aluminium Co. in Maharashtra 20,000 tons. Salem in Madras, 10,000 tons per annum. Mathur—Madras Alumiuinm Ltd. and Korba Aluminium Co. Ltd.

Consumption

During the early years of the introduction of aluminium we used a good deal of it to make kitchen utensils with. That was as it was elsewhere also. Stainless steel is fast replacing aluminium in that field in India as in other countries of the world. Our own production for the time being is just the minimum and we are dependent to a large extent on the imports; which in their turn are restricted for obvious reasons. With the rising tempo of development all round more and more industries will come up for rolling, for extruding of aluminium sheets and tubes and wires.

Imports

The following statement showing imports of aluminium in ingots, sheets and circles will give some idea of the total quantity of aluminium.

1935	2,600 tons
1939	2,900 tons
1942	20 tons
1946	10,300 tons
1960	19,341 tons
1962	3,634 tons

Imports of aluminium does not tell the complete story. It has also shown a regular increase. The following table shows the imports of aluminium in terms of lakh Rupees.

TABLE CXXXIII : *Imports of Aluminium in lakh Rupees*

Year	Imports in Value of Rs. lakhs
1957	801
1958	600
1959	598

1960	729
1961	776
1962	793
1963	1053
1964	646
1965	724

Prospects

Aluminium is the youngest of the non-ferrous group of metals the others being copper, lead, zinc and tin. And yet, it is so fast expanding its uses that it has already replaced copper in many fields. The rapid rise of its utility is a story of the past 50 years or so, and its future is as bright as the metal itself—perhaps brighter than that. In international industrial competition aluminium is one of the dominating factors that gives its producers a powerful influence on other fields of production.

QUESTIONS

1. Give a brief account of the Iron and steel industry in India and describe the present geographical distribution of the industry.

2. Discuss the influence of geographical factors on the localization of the Iron and Steel industry in India. (A.U. 1963.)

3. Give an account of the location, progress and future prospects of any one of the following industries in the Republic of India—

   (a) Iron and Steel.

   (b) Glass

   (c) Cement.

4. Give an account of t e location and progress of metallurgical industries in India, stressing the geographical factors concerned.

CHAPTER 24

Mechanical Engineering Industries

The Mechanical engineering industry is one of the youngest Indian industries but has made considerable progress in the last few years. An overall increase in the quantum of output and an ever-expanding outlay providing fruitful employment opportunities at all levels are the broad features of the working of mechanical engineering industries in India.

Mechanical engineering industries include (1) Machine Tools, (2) Road Making Machinery, (3) Power Driven Pumps and Diesel Engines, (4) Bicycles and Sewing Machines, (5) Manufacturer's machinery *etc.*

Machine Tools

The term Machine tools covers a wide range of articles of various designs and specifications. They may be taken to include such mechanical contrivances as drilling, grinding, milling machines, drill press, circular sawing machines, hand sawing machines, shaping machines and lathes, chucks and presses used for cutting, forming, polishing or otherwise working or treating on wood, glass, metal or any plastic material.

The principal raw materials required for this industry are pig iron, rolled steel products and non-ferrous metals, coal, coke, limestone and timber are also necessary.

Producing Centres. At present, there are over 24 units, two owned by the Government and 22 by private enterprise, manufacturing graded machine tools. The chief producers of machine tools are the Hindustan Machine Tools Ltd., Jalahalli, Bangalore.

Hindustan Machine Tools Ltd., Jalahalli. Before the last World War, there was no real Machine tools industry in India. In spite of serious difficultires and handicaps, the machine tool production rose during the war from an insignificant total of 100 items per annum to about 6000.

With a view to removing the deficiency in the manufacture of machine tools, the Government of India entered into an agreement with the Swiss firm of Overlikon Machine Tool Works, Buehrle & Co., Zurich, for the establishment of a machine tool factory in the country. The agreement envisages the manufacture of 900 high speed lathes, 460 milling machines and 240 heavy duty drilling machines per year. The control and management of the factory was transferred on 1st March 1953 to the Hindustan Machine Tools Limited, Bangalore.

The Company's first Factory at Bangalore went into production in October 1955. The factory produces lathes, milling machines, radial drills, grinding machines, *etc.*

The Company has another factory at Bangalore, which was inaugurated in July 1961.

This factory was built and planned without any foreign financial aid and technical assistance.

The third factory was started in Pinjore near Chandigarh in 1962-63.

The fourth Machine Tools factory came up in Oct. 1964 at Kalamassari, near Ernakulam, Kerala.

The fifth unit of the Hindustan Machine Tool (HMT) was commissioned in December 1965 at Kukkatpalli, near Hyderabad.

Praga Tools Corporation Ltd., Hyderabad. The Praga Tools Corporation was started in 1943. The company manufactures machine tools and accessories, precision tools, auto and diesel parts, railway components, *etc.*

Production. At present over 24 factories are engaged in the production of machine tools of a wide variety and range. The (monthly average) total value of products was Rs. 760.4 lakhs in 1946 but it sagged by about 50 per cent to Rs. 382.4 lakhs in 1947; in 1948, the figure rose to Rs. 456.1 lakhs but again fell to Rs. 394.1 lakhs and Rs. 221.7 lakhs during the next two years.

The capacity of the machine tool industry in terms of value was Rs. 4.38 crores in 1959, as against Rs. 44.4 lakh in 1952. The following table shows the value of machine tools in terms of Rupees.

TABLE CXXXIV : *Value of Machine Tools Industry*

Year	Value (in lakh rupees)
1950-51	30
1951-52	44.4
1952-53	44.1
1953-54	50.0
1954-55	74.4
1955-56	80
1956-57	89.1
1957-58	350
1958-59	376
1959-60	438
1960-61	700

1961-62	930
1962-63	12.60
1963-64	20.10
1964-65	25.70

Imports. Despite our sizeable production of machine tools, we have been dependent on extraneous sources for the supply of the more critical items as will be evident from an analysis of the import statistics. Before the war, India depended almost entirely on imported machine tools, and imports amounted to about Rs. 2 crores annually. During the last World War, machine tool imports were allotted a high priority and our intakes (in Rs. crores) for year to year from 1939-40 onwards amounted to 0.44, 0.56 (1940-41), 0.60 (1941-42) 0.47 ('42-43), 0.29 ('43-'44), 1.46 ('44-'45), 1.72 ('45-'46) and 1.70 ('46-'47). Since the emergence of independence our imports rose still further. From 1947-48 they were Rs. 3.41 crores, Rs. 3.40 crores, Rs. 3.59 crores, Rs. 2.65 crores, Rs. 1.80 crores, Rs. 1.95 crores, Rs. 2.00 crores and Rs. 2.70 crores. With increase in the tempo of industrial expansion, imports of machine tools are bound to increase.

Power-Driven Pumps and Diesel Engines

Power-driven pumps and Diesel engines are required for a multiplicity of industrial purposes, but in view of our concentrated efforts at intensive cultivation on improved lines, a much larger percentage of the internal production and imports are used in our farming operations.

Power Driven pumps are mostly used for lifting water. At present over 30 factories are engaged in producing power Driven pumps and 17 in the manufacture of diesel engines.

The following table showing the installed capacities and monthly average production of the factories reveals the recent trends in the Industries.

TABLE CXXXV : *Production of Power Driven Pumps*
(monthly average)

Year	Installed capacity	000 nos. output
1946-47	0.9	0.5
1947-48	1.0	0.7
1948-49	1.9	1.2
1949-50	2.9	1.2
1950-51	..	..
1951-52	2.9	4.0
1952-53	3.6	2.7

1953-54	5.0	2.1
1954-55	5.1	2.4
1955-56	..	0.9
1960-61	..	19.3
1961-62	..	23.5
1962-63	..	23.8
1963-64	..	24.9
1964-65	..	37.4

India-made diesel engines are fabricated according to B.S.S. specifications and may be well- compared to foreign brands. Though producing upto 35 B. H. P. at present, some of the units are equipped to undertake higher capacity machines upto 300 B. H. P. It has made considerable progress during recent years and aims at consolidating the gains already achieved. The industry has now grown to a level where there are 19 units manufacturing diesel engines in different parts of the country with a capacity of over 23,225 engines per day. The following table shows the production of diesel engines in India.

Year	Diesel engines stationary '000 nos.
1951-50	5.5
1955-56	10.4
1960-61	44.7
1961-62	43.4
1962-63	45.3
1963-64	57.7
1964-65	74.1

Exports. The value of diesel engine exports was Rs. 4.28 lakhs in 1956, Rs. 10 lakhs in 1957, Rs. 10.21 lakhs in 1958, Rs. 13.75 lakhs in 1959 and Rs. 13.59 lakhs during April-Sept., 1960. Indian diesel engines were exported to 25 different countries, the principal buyers being Bahrein, Oman, Cyprus and Thailand *etc.*

Road Making Machinery

Although the road making machinery industry was set up before the war, it received a tremendous stimulus during the period of tight supply and heavy demand during and since the war. Bitumen Boilers and Mixers, Asphalt Mixers, Concrete Mixers, Diesel Engine Road Rollers are the principal items required for modern road buliding.

Before the war, Burn & Co., Calcutta add Bhagat and Sons, Bombay, had been manufacturing these items; the total annual production came to about 100 units and the price per unit was about Rs. 2,000.

Many units are engaged in producing more than 2,500 Bitumen Boilers and Mixers annually, while some units are assembling Asphalt and Concrete Mixers with indigenous and imported components. Diesel engine Road Rollers are being manufactured by Cooper engineering and Jessops.

The indigenous output is inadequate to meet our current demands. In view of the various road development schemes drawn up by the union and State Governments, the industry has bright prospects in the future.

Sewing Machines

The Sewing machine Industry had made a striking progress during its short period of existence. In fact, the heavy involvement of the U.S.A., the U. K., Germany and Japan in the last world war offered the most unexpected stimulus to the two then existing units manufacturing sewing machines on a cottage-scale from indigenous and imported components. The protracted war not only choked our supplies for internal consumption but also stimulated the demand for machines for the ordnance factories and military order suppliers. A sort of black market developed within the country for machines and the much-augmented civilian demand for tailored clothing was met by overworking the limited number of machines that were available at the time. During the period the factory was practically engaged with military orders.

Location of Industry. At the end of the First Plan there were three organised units engaged in the manufacture of complete domestic sewing machines with a total capacity of 46,500 machines per annum.

There are 35 manufacturers of Sewing machines in the Small-scale Sector besides seven firms in the large-scale sector. Of the 35 small units, 14 are in the Punjab, nine in Delhi, four in Rajasthan, three in Uttar Pradesh, two in Jammu and Kashmir and one each in Maharashtra, Gujarat, Madhya and Andhra Pradesh. Of the seven big manufacturing firms, West Bengal and Punjab have three each and the seventh is in Delhi.

Production. At present domestic and tailor model machines are produced in the country. Re-viewing the position of the industry at the third enquiry in 1954 by the Tariff Commission observed : "The industry has consolidated its position, established itself on a secure basis and can now carry on even without protection. As regards quality, the domestic sewing machines produced by the principal units has greatly improved and compare favourably with that of imported units. There is now no significant prejudice against such machines produced by the above mentioned firms."

The following table shows the production of Sewing machines in India.

Year	Machines
1952	50,040
1953	62,424
1954	80,196
1955	101,472
1956	130,392
1957	167,484
1958	205,212
1959	251,904
1960	295,788
1961	317,124
1962	323,104
1963	347 000
1964	282 000
1965	330,000

Exports. Exports of Indian Sewing Machines fetched foreign exchange worth Rs. 20 to 40 lakhs in 1958 as against 5.51 lakhs for the whole of 1957.

In 1959 the value of export was as much as Rs. 23.96 lakhs and during April, Sept. 1960 it was Rs. 8.94 lakhs.

The number of sewing machines exported in 1958 was 11,708 as against 4,465 during 1957. During 1959 the number was 22,702 and during April-Sept. 1960 it was 10827.

The countries to which Indian sewing machines are exported include British Guiana, Afghanistan, Thailand, Ceylon, Malaya, Singapore, the U.S., Kenya, Jordan, Madagascar, Tanganyika, the Sudan, Pakistan Uganda, Iraq, Sierra Leone, Rhodesia, Sudi Arabia, Zanibar, Manuritius, Burma, Nepal and Vietnam.

Bicycle Industry

At present twenty one factories are engaged in the manufacture of complete bicycles and seventy eight in the production of spare parts and accessories. Close foreign collaboration has been secured by two units, *viz.*, Sen-Raleigh industries and T. I. cycles (Hercules). Sen Raleighs through their sister firm National Tanneries, are manufacturing cycle saddles according to the specifications of well-known foregn brands.

There are 21 manufacturers of Bicycles in the large-scale sector besides 78 units in the small-scale sector. Of these big units, Uttar

Pradesh has six, West Bengal three, Punjab five, Delhi three and Madras, Maharashtra, Assam and Bihar have one each. There are 78 units in the small sector; of these 22 are in the Punjab, 14 in Delhi, 10 in West Bengal, nine in Uttar Pradesh, eight in Maharashtra and Gujarat, four in Madhya Pradesh and two in Madras. Five units in Rajasthan, two in Mysore and one each in Andhra Pradesh and Orissa are to go into production soon. See fig. 58.

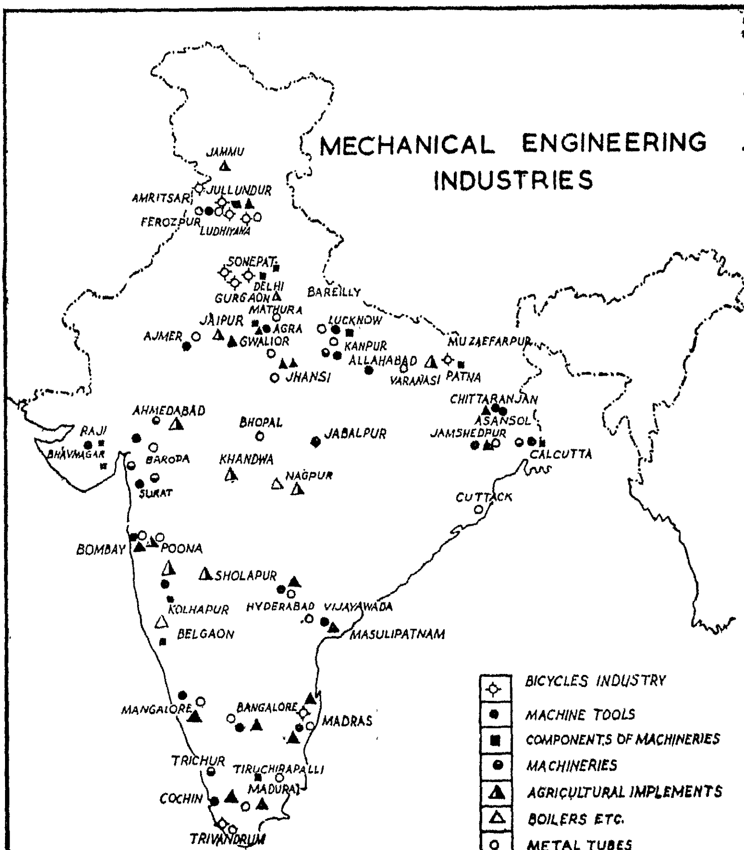


Fig. 58. Mechanical Engineering Industries

Production. The actual output of Bicycles were 3000 in 1946, 4000 in 1948, 5000 in 1949 and 8000 in 1950. The following table shows the production of bicycles in India.

Year	000 nos. (Production)
1950-51	99
1955-56	513
1960-61	1013
1961-62	1043
1962-63	1111
1963-64	1259
1964-65	1442

Exports. Indian cycles have been successfully introduced, on a commercial scale, in six foreign countries. The exporting countries were Burma, Ceylon, Malaya, Afganistan, Mozambique and Nigeria *etc.*

Scooters and Motor Cycles

World War II was responsible for a number of technical developments in all directions, whether in the fields of engineering, electronics or transport. In the latter it proved to be the beginning of the diesel age, but above all it provided the middle and poorer class individual with one of the greatest advances in the field of personal transport—the motor scooter.

In 1955, the Government of India sanctioned a five-year phased programme for the manufacture of Lambretta Scooters, Scooterettes and three wheelers in India. The task was entrusted to a Bombay Organization, Automobile Products of India, Ltd., who lost no time in getting down to the job on hand.

The Lambretta was introduced to the market in India late in 1955. The importance and place of the motor cycle in our economy is self-evident. Between 1931 and 1951 great changes have come about in the way of living of our people. People engaged in trade, commerce, transport and production (other than agriculture) have trebled. In effect, large numbers of our people have migrated to the towns and cities. The number of cities with a population of over 100,000 alone has more than doubled, not to speak of the total increase in the number of towns generally.

Motor Cycles are in extensive use in the police and defence departments of states all over the world. On a motor cycle you can go anywhere, no matter how good or bad the roads. You can go long distances at great speed, without fatigue.

Production. Enfield India, Ltd., have therefore, ventured to pioneer the establishment of the motor cycle industry in India. Planned and promoted in collaboration with the Enfield Cycle Company, Redditch England, they have established their factory at Tiruvottiyur near Madras and have commenced production of the world-famous Royal

Enfield motor cycle and the R. E. three wheeler chassis. Their approved programme provides for the production of 5000 motor cycles and 1800 three wheelers a year. The actual production is shown in the following table.

TABLE :—*Production of Motor Cycles and Scooters*

	000 nos.
1955-56	0.9
1960-61	19.3
1961-62	23.5
1962-63	23.8
1963-64	24.9
1964-65	37.5

Prospects. The future of the motor cycle industry is very bright indeed. With increasing production in every field of our national economy, people (and goods) must go places to serve to produce to sell and to buy to keep their business moving.

Agricultural Implements and Machinery

There are several factories, engaged in the production of improved implements like ploughs, seeding, planting and threshing machinery; hand tools like spades, shovels, hoes, pruning and cutting knives; irrigation equipment like persian wheels, manually operated water pumps, plant-protection equipment like sprays and dusters and machinery for processing agricultural products like oil ghanies, cane crushers, chaff-cutters, ground nuts and cotton decorticators, oil presses, tobacco burns *etc.*

Constructional Machinery

A good number of firms are engaged in the manufacture of items like cement mixer, stone crusher, tar boiler, asphalt mixer, concrete vibrator, *etc.*

Several factories are engaged in the production of mill machineries, tea processing machinery. Drilling machines, planing machines, shaping machines, grinding and polishing equipment, presses, punches and shearing machines *etc.*

QUESTIONS

1. Discuss the geographical and economic bases of Indian Mechanical engineering industry.
2. Write an essay on Mechanical engineering industries in India.

CHAPTER 25

Heavy Engineering Industries

India is taking giant strides towards its goal of equal opportunity and full employment for its people. A multi-purpose project here, a steel plant there, a national extension scheme in every other village, and a host of large undertakings help further the welfare of our people, and change the face of our country.

The pace of progress has quickened. People are on the move. Their wants and aspirations have grown. Their standard of living is improving with every advance India makes in its planned attempt at self-sufficiency in our basic needs.

Development of transport is a pivot upon which our national plans revolve. The first Five Year Plan saw the rehabilitation of the railways in a big way and also helped to establish the motor car and bicycle industries on a stable footing. It also laid the foundation for the progressive development of the automobile industry.

AUTOMOBILE INDUSTRY

All the world over, the automobile industry, which plays such a vital role in modern transport, is cited as the classic example of mass production. It converts a vast stream of diverse raw materials into highly standardised products for sale at prices which yield comparatively high wages to its employees, big dividends to its share-holders and large values to its customers. These results are obtained, in part, through the technique of mass production, characterised by large-scale operation, tapered integration, special purpose equipment, sub-division of labour and power-driven assembly lines.

Then, again, there is the important problem of annual redesign of product, shrewd buying, and able merchandising and sales promotion efforts. In all countries where it has been established, it has gradually developed into an industry of the first magnitude and the huge size of the industry, particularly, in the U.S.A., is astonishing having regard to the fact that it is out and out a late twentieth century industry.

Even the U.S.A., where during 1954 there were nearly 39 million passenger cars, in India there were only four registered automobile companies. In India, the first motor car was imported in about 1898 but since that time, the number of automobiles in this country has not grown in such a spectacular manner as in the U.S.A.—the number of all kinds of motor vehicles on the roads in India not exceeding three lakhs.

Raw materials

Now the essential pre-requisites for the successful and rapid establishment of such industries are, by no means, lacking in the country. We have plenty of raw materials in the shape of metalic ores found in many parts of the country and the funcioning of the state-sponsored steel projects, remove the greatest hurdle in getting all the steel that our heavy industries would be requiring.

We have, of course, no scarcity of labour nor of technicians. There is, no doubt, a relative shortage of power but that deficiency is going to be overcome soon enough with the completion of the giant river valley projects. In the meantime, the country has an abundance of coal. Therefore, when people are found to be making a grouse of shortage of one essential pre-requisite or the other, what is really meant is comparative but not relative shortage.

The materials fall under three categories—

(1) Engineering raw materials like steel, iron, leather, paints, *etc*;

(2) Finished engineering goods like plastic parts, tyres, batteries *etc*., which are specially ordered from recognized manufacturers in various fields; and

(3) Tools, machinery and other equipment needed for the maintenance and running of the factory.

Trading Companies. The automobile industry which had been developing in India since 1928 when the General Motors commenced assembling trucks and cars from components and parts imported from the U.S.A. in their Bombay factory that the industry may be said to have made a beginning, however unsatisfactory it might be. The Ford Motor Co. of India Ltd., commenced C.K.D. assembly of cars and trucks at Madras in 1930 and at Bombay and Calcutta in 1931. The real beginning of the industry, however, was made in 1944 when two companies, the Hindustan Motors Ltd., and the Premier Automobiles Ltd., with an authorised capital of Rs. 20 crores and Rs. 10 crores respectively were established with a programme for progressive manufacture of complete automobiles. The Hindustan Motors Ltd., entered into Technical Collaboration Agreement with Morris Motors Ltd., for the assembly and manufacture of Hindustan cars and with the Studebaker Corporation for the assembly and manufacture of their cars and trucks in India.

Similarly, the Premier Automobiles Ltd., worked with Chrysler Corporation as also with the Flat Societa' Per Azioni of Italy for the assembly and manufacture of Flat Cars. In addition to the above two units, the Government have approved the programmes of the Standard Motor Products of India Ltd., Madras, and the automobile Products of India Ltd., Bombay, for the manufacture of motor vehicles. Govern-

ment have also recognised the Asok Motors Ltd., Madras, as manufacturers. Besides these firms, five other c.k.d. Vehicle assemblers were established between 1946 and 1950 namely, Dewar's Garage and Engineering Works, Calcutta, Peninsular Motor Corporation Ltd., Calcutta, French Motor Car Co. Ltd., Bombay, Rutus Grouf, Ashok Leyland and Addison and Co. Ltd., Madras.

PRODUCTION

It was in 1949 that the first step was taken by Premier Automobiles, Ltd., of Bombay, to manufacture automobiles in India. The complete programme consisted of successive stages spread over a number of years, culminating in fully Indian-made cars and trucks. In less than eight years, over 60% of automobile parts were successfully produced and are now being used in their vehicles.

It is, however, not quite accurate to count the period from 1949. It would be more fair to put the date of commencement of manufacturing as 1953, when the Tariff Commission recommended establishment of the Indian automobile industry.

The steps taken by the Government have helped the industry to a great extent and facilitated progress in the matter of production of various components and in providing stimulus to a number of ancillary industries. Progress of the industry in general has been satisfactory. Production of automobiles has increased from 13,920 vehicles in 1953 to 14,410 in 1954 to 23,088 in 1955 and 32,138 in 1956.

The following table shows the production of automobiles in India.

TABLE CXXXVI : *Production of Motors etc. in India*

Year	Cars	Jeeps	Trucks	Vehicles	Total
1956	12,680	4,440	10,920	3,408	32,138
1957	11,604	4,086	11,892	3,756	31,950
1958	7,812	3,552	11,028	4,104	26,796
1959	11,988	4,656	10,728	4,848	32,292
1960	19,092	5,508	20,964	6,108	52,140
1961	21,660	7,056	19,524	6,072	54,312
1962	23,328	7,526	21,156	6,084	57,816
1963	28,000	..	26,500	..	54,500
1964	29,200	..	29,500	..	58,700
1965	34,000	..	36,800	..	70,800

The automobile industry in India, as in other countries, comprises both the automobile manufacturers and component manufacturers, though

the progress so far made in automobile manufactures has not progressed to the extent desired and necessary, and the manufacture of components of ancillary character is also in an early stage of development.

Problems of industry

In spite of the progress in the manufacture of an increasing number of components the industry has not developed at a fast pace and to the fullest extent on account of a number of problems it has to face.

The most important problem faced by the automobile industry is the utilization of its capacity fully and production of automobiles at reasonable cost. The industry is a highly complex one which involves the manufacture of nearly ten thousand different parts and components, and the financial outlay involved is very large. Further, the economies of the industry are such that it can work only on the basis of mass production. Therefore, for a real reduction in prices the volume of demand must go up. Apart from the low demand of the prices of raw materials, which are mainly imported, and of plant and equipment and heavy labour and other overheads are contributory factors to the high cost of automobiles.

The demand for automobiles in the country has never been appreciable. At the present rate of consumption, it appears that there is little scope to effect any appreciable economies and reduce the prices of vehicles. The unexpected situation caused by the heavy drain on the country's foreign exchange resources has been a source of anxiety to the industry. As imports will be restricted, such items as have not been produced locally will have to be produced, and the import of capital goods for their manufacture will be necessary. The Government should, therefore, assist the industry by releasing exchange for such capital equipment in sufficient sums and at the proper time as otherwise the industry will not be in a position to go ahead with its production programmes.

Prospects of the industry

The Indian automobile industry is still in an infant stage of development considering the fact that as against the production of 7 million vehicles in the U.S.A., and over a million in the U.K., India produced and assembled about 70,800 vehicles in 1965. In spite of this limited production and demand in the country, a number of new industrial concerns have come into the field and are rapidly growing. Items which automobile manufacturers are procuring from subsidiary industries run to several hundreds. Production and demand are no doubt small at present but with greater utilization of the production capacity of the industry and rapid road transport development there will be much scope of developing the demand further and creating new outlets for investment and employment in over 200 industries which are necessary to feed the manufacture of automobiles.

LOCOMOTIVES

The railway system of the country with nearly 64,000 kilometres of track has now been in existence for well over a century and functioning as the most important means of transport and communication, which is so vital both from the point of view of economic development as much as for the defence of the country. It has been one of the worst legacies of the foreign regime that during this long period they consistently pursued a policy of frowning on the development of any type of the railway rolling-stock industry. All that they did was to put up some repair and maintenance shops in different parts of the country.

Post freedom strides

It was only after the country attained an independent and sovereign status that plans were drawn up for the establishment of the Chittaranjan Locomotive Factory and the expansion of the Tata Engineering Locomotive Co. for the manufacture of Locomotives and boilers. The topmost priority was naturally granted to the completion of the State owned Chittaranjan Works while liberal assistance, both financial and otherwise, was also accorded to the T.E.L. Co. The Textile Machinery Corporation Ltd. set up in 1950 was a new division for the manufacture of boilers and heavy engineering works. The history of the locomotive and boiler manufacturing industry of the country is mainly the history of the progress and development of these three units.

Chittaranjan Locomotive Works

For lessening the dependence of the Indian Railways upon foreign sources the Government started a Locomotive Workshop at Chittaranjan in 1948 at a cost of Rs. 14 crores. Extensive level land with hard soil of Chittaranjan area is a most suitable site for the erection of the plant.

Steel supply for the Chittaranjan locomotive comes from Durgapur and Tata Iron and Steel Company.

Coal for the plant comes from Raniganj an other fields, which are only 17 kilometres by railway from Chittaranjan.

The preliminary requirements of electricity were met by the D.V.C.

Chittaranjan Locomotive enjoys a favourable location in respect of railways and road. It is connected with Calcutta harbour. Some railway lines have been recently constructed to serve the plant for hauling raw materials which are required for the plant.

The first locomotive, a W. G. Broad Gauge Locomotive for goods traffic was assembled at the Chittaranjan Works in November 1950. Production of this type of locomotives totalled 27 by the end of April 1952 and by January 1954 the Chittaranjan Works turned out the

hundredth locomotive and by February, 1955, it attained the distinction of having completed the second century in output.

Production of Locomotives. The annual production of this unit which was 120 has since been stepped up to 200. It now produces over 200 W. G. type of locomotives a year. It has also begun production of electric engines. A 10,000 ton capacity foundry is being set up for heavy casting for the railways.

Another satisfactory feature of this production tempo is that the Chittaranjan Works has now been producing over 75 per cent of the 5300 components and 150,000 parts required for the manufacture of one B.G. type locomotive.

TELCo's Production

The Tata Locomotive and Engineering Co. Ltd., a portion of whose share capital has also been subscribed for by the Government has technical linkup with Krauss-Maffei of Munich which provides up-to-date technical advice and the services of skilled engineers and technicians. This factory has produced 148, assembled the first thirty Y. G. class Metre Gauge goods locomotives and 148 loco boilers. During 1954 the factory turned out 50 Y.P. class M.G. passenger locomotives.

In 1964-65, TELCO produced 68 steam locomotives against 56 in 1963-64. India has become self-sufficient in respect of steam locomotives and may even export them. The same is true of wagons and coaches.

Diesel Locomotive Works, Varanasi

This project at Varanasi was sanctioned in August 1961 with an estimated cost of Rs. 19.57 crores. In February 1962, a collaboration agreement was signed with ALCO of the U.S.A. The Diesel Locomotive Works, set up at Varanasi, with a planned capacity of 150 main line B.G. diesel-electric locos per year, started with assembling locomotives from imported components. The first loco was commissioned in January 1964. Up to the end of 1965, 12 locos were assembled from imported components and 37 manufactured in the factory. An outturn of 150 locos per year is expected to be reached by the end of 1967-68.

Wagon Building. The building of Railway wagons in India is a long established industry. The Railways have their own equipment for repairing and reconditioning wagons, but they do not ordinarily construct new wagons. A programme for 10,000 wagons was made in the middle of 1942 to be completed by the middle of 1944. But only 1,800 wagons were delivered in that period, the delay being largely due to the inadequate supply of wheels and axles.

The Integral Coach Factory at Perambur went into production in October, 1955. Originally designed to produce only broad gauge coach shells, its production has been expanded and diversified to turn out furnished coaches, both broad and metre guage, electric multiple unit stock diesel rail cars and air conditioned coaches.

Besides, the Bharat Earth Movers Ltd., (formerly Hindustan Air Craft Ltd.) are producing about 300 broad gauge and a private sector company, Jessops, about 300 metre gauge passenger coaches and 70 broad gauge electric multiple unit coaches per year.

SHIP BUILDING

The importance of shipping in a country with a long coast line and a large maritime trade can be easily appreciated. Ships have been built in India from time immemorial. This will be evidenced from the observations of Dr. R. K. Mukerjee who remarks, "....for full 30 centuries India stood out at the very heart of the old world, and maintained her position as one of the foremost maritime countries. She had colonies in Pegu, in Cambodia, in Java, in Sumatra, in Borneo and even in the countries of the Far East as far as Japan. She had trading settlements in Southern China, in Malaya Peninsula, in Arabia and in all the chief cities of Persia and all over the east coast of Africa. She cultivated trade relations not only with the countries of Asia, but also with the whole of the then known world, including the countries under the dominion of the Roman Empire and both East and West became the theatre of Indian commercial activity and gave scope to her naval energy and throbbing international life."

In the years immediately before the war, some advance had been made in the construction of the larger vessels also. The enterprising Indian firm, the Scindia Steam Navigation Company, laid out a large shipyard at Vizagapatnam for the construction of steamers upto 8,000 tons (deadweight).

Hindustan Shipyard Limited, Vishakhapatnam

This venture was pioneered by the Scindia Steam Navigation Company Ltd. The Government of India acquired a major controlling interest in the shipyard. Messrs. Hindustan Shipyard Limited, a private limited company in which the Government of India hold two-thirds of the shares and the Scindia Steam Navigation Company the balance of one third, took over the management of the shipyard on and from 1st March, 1952. The management is entrusted to the Hindustan Shipyard. The first ship built in the yard was launched in March 1948. The shipyard is now manned entirely by Indian personnel. The Hindustan Shipyard has so far built 45 ships. A programme for development during the Third Plan was drawn up at an estimated cost of Rs. 2.44 crores, a part of which costing Rs. 1.13 crores has been sanctioned

by Government. Further development at a cost of Rs. 1.68 crores is under consideration. Government is also considering to reorganise the shipyard to raise its capacity to six ships of 12,300 D.W.T. each per year by 1967-68.

The Fourth Plan tentative programme involves an outlay of over Rs. 12.90 crores. The entire development programme is to be finalised after the decision on reorganisation.

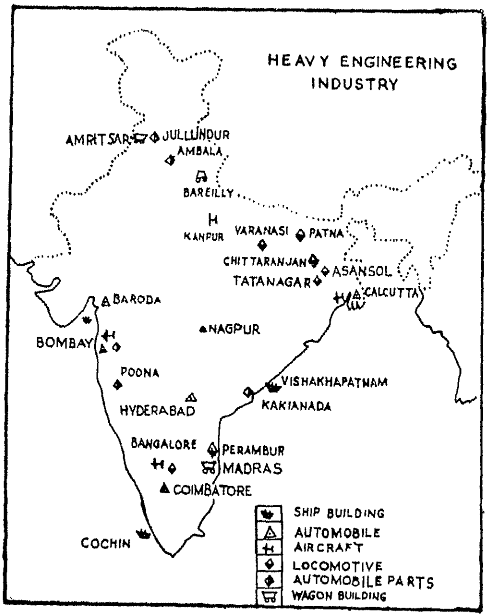


Fig. 59. Heavy Engineering industries in India.

The Second Shipyard is proposed to be built in Cochin with an initial ship-building capacity of Rs. 60,000 G.R.T. per year. Land has been acquired for the purpose and a sum of Rs. 20 crores was provided in the Third Plan for the project. Figure 59 shows the Heavy Engineering Works in India.

AIRCRAFT

A new limited company, the Hindustan Aeronautics Limited, was set up with an authorised capital of Rs. 50 crores to run a complex of factories for the manufacture of MIG-21 aircraft. It has taken under its wings the Hindustan Aircraft Limited, Bangalore, and the Aircraft Manufacturing Depot, Kanpur, which had been working independently.

Initially, the Aeronautics India Ltd., was formed in August 1963 for the manufacture of aircraft, aero-engines, electronic equipment,

missiles etc., and had taken over from the Indian Air Force on June 1, 1964, the Aircraft Manufacturing Depot at Kanpur. The aircraft manufacturing project being undertaken in collaboration with the U.S.S.R. Government was assigned to the Company on March 20, 1964 and on October 1, 1964, the company was amalgamated with the Hindustan Aircraft Ltd., Bangalore.

The amalgamated company is responsible for the following units :

(1) Aircraft Factory at Bangalore,

(2) Aircraft Manufacturing Depot at Kanpur,

(3) Airframe Factory at Nasik,

(4) Aero-engine Factory at Koraput, and

(5) Electronic Equipment Factory at Hyderabad.

The Hindustan Aircraft Ltd.—HAL—was established at Bangalore. It is now a Government factory for manufacturing aircraft. In 1956, the Government of India entered into an agreement with Messrs. Follance Aircraft Ltd., U.K. for the manufacture of the Gnat, at HAL. The factory has also been building supersonic jet aircraft. It has designed and developed a light four-seater aircraft, Krishak, an Ultralight multi-purpose aircraft, Pushpak and a six cylinder piston aero-engine.

The HAL has also manufactured several Alouette Helicopters. During 1963-64, HAL handed over the first batch of Supersonic jet fighters to the Indian Air Force, and the first India-made basic jet trainer, H.J.T.-16 made its maiden flight.

The Kanpur division of the HAL manufactured 3 more HS-748 aircraft, while its Kanpur branch manufactured aircraft for flight.

The Bharat Electronics Limited, Bangalore, which started production in 1956 with only two electronic items, diversified its production and manufactured over 70 different items of equipment, ranging from a tiny transmitter to highly sophisticated radars.

The Bharat Heavy Electricals Ltd., was established in 1964 and is responsible for the following units—(1) High Pressure Boiler Plant, Tiruchirappalli (Madras) (2) Heavy Power Equipment Plant Ramchandrapuram (Andhra) and (3) Heavy Electrical Equipment Plant, Ranipur near Hardwar (U.P.) is being set up with Soviet assistance, and designed to manufacture steam turbines and generators, water turbines and generators, medium and large scale industrial electric motors.

QUESTION

1. Examine and compare with other countries, the factors which underlie the present location and character of the Ship-building industry in India and the possibilities of its future development.

CHAPTER 26

Electrical Engineering Industries

The emergence of the electrical Engineering industries on well-planned modern lines, during the post-war period assured us of self-sufficiency in respect of such essential utility goods as electric fans, electric lamps, dry cells, Storage batteries radio-receivers, house service matters. Post-independence development in the sphere led to the setting up or acceleration of efforts for a still further expansion of the range of products like electric motors, power and distribution transformers, electric wires and cables, conduit pipes etc.—items essentially needed for the utilization of electrical energy the benefit of the millions inhabiting the sub-continent. The large scale river-valley and hydel projects undertaken under the plans offered the much-needed stimulus to entrepreneurs to cover these hitherto unexplored lines of manufacture.

Before the last world war we had only a few factories engaged in the manufacture of electric fans, lamps, dry cells, storage batteries and radio-receivers; but they were mosty mere assembling units completing the gadgets with foreign components. The non-availability, and in some cases, extremely tight availability of such materials during the years of war, attended by the stimulation of heavy war demands offered an impetus to indigenous producers to explore new grounds and by the end of the war, they had succeeded in developing the facilities for producing the items in their own factories, except in regard to some critical components and materials.

According to Thomas, "War provided an opportunity for the expansion of these industries and for the starting of the production of new items." The following are some of the significant developments that have taken place during the years 1947 to 1967 in respect of the newer engineering industries :

Power & Distribution Transformers

Importance. Power and distribution transformers provide the essential link between the generation and distribution of electricity. They are generally used for either stepping up or stepping down the voltage in A. C. System.

Historical Development. The first transformer works was set up by the Mysore Government Electric Factory in 1937. The outbreak

of war choked our supplies of, and increased the demand for them, when the topmost priority was accorded to their imports—the figures, in Rs. lakhs, from year to year between 1938-39 and 1942-43 being 263, 21.93, 19.12, 17.84 and 13.44.

It was during this war period that the Associated Electrical Industries and Crompton Parkinson Works who had been bulk suppliers of similar products produced by their U.K. principals for the major industries, principally cotton and jute textiles—started the production of transformers within the country. In 1947, four factories were engaged in the line with an annual rated capacity of 102.000 K.V.A. the bulk of the output being confined to ratings between 250 K.V.A.

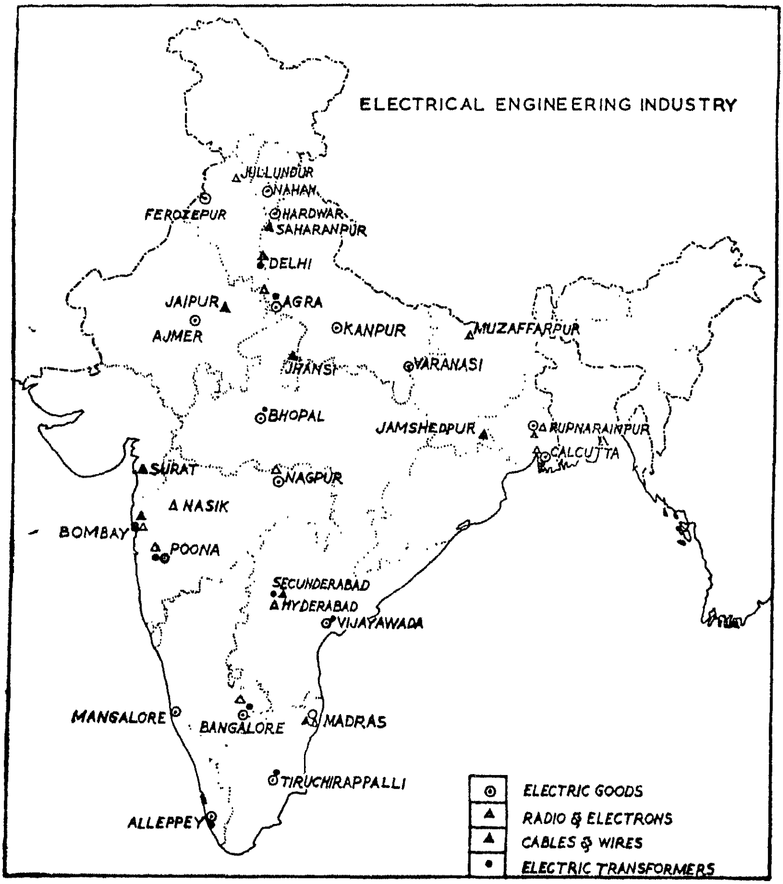


Fig. 60. Electrical Engineering Industry, in India.

and IIKV on H.T. side. Since Independence the industry made remarkable progress.

Producing Centres. The only producer before the war was the Government Electric Factory, Bangalore, which started production in 1936-37. After the outbreak of war two more firms began production, Associated Electrical Industries Manufacturing Co., Calcutta, which began production in 1941 and Crompton Parkinson Works, Bombay, starting production in 1943.

At present over ten factories are engaged in transformer making. The monthly rated capacity and production, in thousand K. V. A. were 14.6 and 6.8 in 1948; 18.8 and 9.1 in 1949; 25.5 and 14.3 in1950; 25.0 and 16.3 in 1951, 25.3 and 17.9 in 1952, 27.3 and 25.7 in 1953 and 27.3 and 25.7 in 1953 and 27.3 and 33.3 in 1954.

Besides, two more units have been set up in Travancore and Faridabad which went into production in 1957. Fig. 60 shows the Electrical Engineering Industries in India.

Production. The actual production of Power Transformers in India is given in the following table.

TABLE CXXXVII :—*Production of Power Transformers in India.*

Year	rodPuction (in thousand K.V.A.)
1952	214.8
1953	308.4
1954	399.6
1955	565.2
1956	919.2
1957	1219.2
1958	1126.8
1959	1057.2
1960	1248.8
1961	1774.8
1962	1930.3
1963	2400.2
1964	2700.6
1965	3500.9

Electric Fans

Before the World War II, India depended on imports for all the raw materials and component parts of electric fans. Most of the raw materials for fan manufacture were obtained by importation before the war.

About thirty factories are engaged in the production of electric fans. Most of them are concentrated in West Bengal as is evident from the following table.

Distribution of Factories in India

State	No	Efficiency %
West Bengal	17	68
Maharashtra	5	13
Delhi	5	13.5
Punjab	2	4.5
Rajasthan	1	1.2
Total	30	100.0

Out of 30 factories reporting their working results in 1962, one had between 1000 and 1,999 workers on the roll, two between 500 and 999, one between 250 and 499, five between 100 and 249, two between 50 and 99, while others were small units with upto 50 operatives.

The monthly rated capacity and output in lakhs increased steadily from year to year from 0.12 and 0·09 in 1946 to 0.21 and 0.13 in 1947; 0.21 and 0.15 in 1948; 0.25 and 0.15 in 1949 and 0.23 and 0.16 in 1950. The following table shows the production of electric fans in India since 1952.

TABLE CXXXVIII : *Production of Electric Fans*

Year	Production
1952	195,600
1953	199,200
1954	238,800
1955	290,000
1956	238,400
1957	524,400
1958	636,000
1959	727,900
1960	990,000
1961	1,074,000
1962	11,41,200
1963	1,111,000
1964	1,170,000
1965	1,275,000

EXPORTS

India now exports more than one hundred different engineering products to a number of countries. One of the items is electric fans, production of which has rapidly increased in recent years. Export of complete electric fans during 1959 alone amounted to Rs. 5,34,941 as against Rs. 1,96,978 of previous year.

Fans made is this country have been specially designed and built for use in tropical conditions and our neighbours with similar climatic conditions find special advantage in India-made fans. Electric fans are now being exported to more than forty countries in the world. Kuwait and Ceylon are leading customers, their off take being Rs. 5,26,326 and Rs. 2,89,826 respectively. Other important customers are Singapore (Rs. 1,69,800) Malaya (Rs. 1,20,956) and S. Arabia (Rs. 1,18,445).

Electric Lamps

This heading excludes lamps for automobiles and torches and also special types of lamps required for projectors, studios *etc.*, and refers to electric bulbs used for lighting of factories, workshops, mills and residential buildings.

Seven factories were engaged in the electric lamp industry in 1948 and 1949. Production of lamps in India was confined to seven firms mentioned below—

1. Associated Electrical Industries (India) Ltd.;
2. General Electric Company (India) Ltd.;
3. Philip Electrical Company (India) Ltd.;
4. F. & C. Osler Ltd.;
5. Greaves, Cotton and Crompton Parkinson Ltd.;
6. Balmer Lawre and Co. Ltd.;
7. Siemens (India) Ltd.

Two new units started work in 1950, making the number nine. The total, fixed and working capital of the factories showed a steady increase, in Rs. crores, from 0.73, 0.44 and 0.29 in 1948 to 0.99, 0.66 and 0.33 in 1949; 1.57, 0.88 and 0.69 in 1965; 1.78, 1.26 and 0.52 in 1951 and 1.84, 1.31 and 0.53 in 1952. There was a corresponding year-to-year increase in the number of employees and workers, while the number of persons other than workers fluctuated within narrow limits.

The total salaries, wages and other benefits of the employees showed a steadily upward trend from Rs. 15 lakhs in 1948 to Rs. 20 lakhs, Rs. 20.9 lakhs, Rs. 25.4 lakhs and Rs. 29.9 lakhs for the succeeding years. The expenses incurred by the industry for materials, fuels *etc.*, consumed increased from year to year, due *inter alia*, to the sharp rise in prices of materials during the Korean War boom and also to the consumption of more and more materials. Depreciation allocations also advanced sharply.

There was a steady increase in the monthly rated capacity and output, shown in seriatim in lakhs of incandescent filament lamps from 10.83 and 6.76 in 1946 to 10.83 and 6.33 in 1947; 11.98 and 7.71 in 1948; 15.00 and 11.37 in 1949; 19.20 and 11.92 in 1950; 19.20 and 12.93 in 1951; 21.34 and 17.34 in 1952; 24.00 and 16.69 in 1953 and 24.00 and 16.38 in 1954.

At present eleven factories are manufacturing incandescent filament lamps, and one of them flourescent lamp-making. Another modern factory has concluded technical collaboration agreement with a leading house in Japan for the production of fluorescent lamps. A number of factories are engaged in the manufacture of miniature bulbs for torch lights, motor cars, motor cycles *etc.* The following table shows the production of electric lamps in India.

TABLE CXXXIX *Production of Electric Lamps in India*

Year	Production (000)
1952	20,880
1953	18,768
1954	23,076
1955	24,235
1956	30,728
1957	33,149
1958	30,476
1959	34,841
1960	41,395
1961	46,890
1962	58,542
1963	61,600
1964	71,800
1965	68,100

Electric Motors

Electric motors are required for various power drives in every industry and also for domestic purposes, irrigation works, *etc.*

P. S. C. & Sons Charity Industrial Institute is the first factory to start the manufacture of electric motors in India before the war at Coimbatore, producing 200 A.C. 3-phase Squirrel Cage motors from 1 to 10 h.p. annually. The Second to step into the sphere was Kirloskar Brothers, Kirloskarwadi, Satara. World War II caused a total stoppage in supply from extraneous sources and offered an incentive to indigeneous producers to explore this line. Much needed assistance in the shape of imported raw materials has been extended by the authorities.

Post-independence developments brought about further consolidation of the industry as is reflected in the gradual increase in monthly rated capacity and output in thousand h.p., from 5.0 and 3.8 in 1946; 8.3 and 3.2 in 1947; 12.5 and 5.0 in 1948; 16.7 and 5.7 in 1949; 12.5 and 6.8 in 1950; 12.7 and 11.9 in 1951; 16.7 and 13.1 in 1952 and 16.7 and 13.5 in 1953.

Production. Production of fractional horse power motors was taken up in 1947. By 1950, the range was extended to 50 h.p. in the Squirrel-cage and slip-ring types. The manufacture of high torque motors commenced during recent years. There are at present 20 units in the large scale sector with a total annual capacity of 602, 520 H.P. Besides, there were 31 units in the Small Scale Sector in 1958 whose annual capacity was 130,000 H. P. In addition, there are several small units which are not registered but which assemble electric motors and manufacture parts. In 1959 there were 74 units in Small Scale Sector with a production capacity of 266,204 H.P. The following table shows the production of electric motors in India.

TABLE CXXXX *Production of Electric Motors*

Year	Production (000 h.p.)
1952	157.2
1953	162.0
1954	187.0
1955	252.0
1956	358.8
1957	469.2
1958	624.0
1959	573.0
1961	728
1962	873
1963	1041
1964	1182
1965	1436

Electric Wires and Cables

The Indian Cable Co. was set up in 1921 to produce electric wires and cables. But an overwhelmingly large percentage of our requirements was met from imports—the lone producers manufacturing only the oridinary trade types of bare copper wire, cotton-covered wire and various types of V. I. R cables. Top-priority war demands induced the Government of India to set up a factory for manufacturingD-type signalling cables in Tatanagar. Indian cables also expanded their capacity

and range of products. The national Insulated Cable Co. also started work during the war—all the units working under the statutory control of the Director General of Munitions Production.

Raw materials such as lead, rubber, hessian, french chalk, barium sulphate, paraffin wax and naphtha cotton and galvanized irons are also obtained locally.

Since the cessation of hostilities, extensive expansion of the industry has taken place and today over seven factories are busy producing bare copper conductors, four aluminium conductors, two winding wires, four rubber and plastic-insulated cables and flexibles.

Hindustan Cables Limited, Rupnarainpur (West Bengal). The manufacture of insulated telephone cables was undertaken under an agreement entered into with Messrs. Standard Telephone Cables Ltd. of the United Kingdom. The Hindustan Cables Ltd. was incorporated in Aug. 1952 with the object of manufacturing tele-communication cables and accessories mostly required by the Post and Telegraphs Department. Production commenced in 1960.

Production. Actual production of bare copper conductors winding wires, rubber insulated cables and flexibles, A.C.S.R. Cables is as follows.

TABLE CXXXXI : *Production of Electric Cables and Wires*

Year	Copper conductors	Winding wires	Rubber insulated cables *etc.*	A.C.S.R. cabels
1956	10,255	761	105.6 yd.	11,285
1957	8,554	1,016	103.9 „	15,388
1958	8,200	2,300	120.0	14,000
1959	6,570	4,669	165.0	17,000
1961	10.1 (000 tons)	—	—	23.7 (000 tons)
1962	7.1 („)	—	—	22.6 („)
1963	4.2 („)	—	—	31.6 („)
1964	5.2 (,)	—	—	33.0 (,)
1965	5.3 („)	—	—	48.8 („)

Prospects. The large scale hydel and electrification projects on hand offer a vast scope to the capacity utilization of the installed potential.

Radio-Receivers

Most significant strides have been made in the manufacture of radio-receivers and the monthly capacity and production has risen from 667 and 253 sets in 1947 to 11,508 and about 6000 units. Currently,

fifteen modern factories are engaged in the sphere, some on the assembly lines system.

The production programme of the Bharat Electronics Ltd., Bangalore included the manufacture of general-purpose receivers and medium power transmitters as well as other electronics equipment not only for the Armed Forces but also for other departments like the Civil Aviation *etc.* The manufacturing of Radio-Receivers is mostly confined to Calcutta, Bombay, Bangalore and Delhi *etc.* The following table shows the production of Radio-Receivers in India since 1956.

TABLE CXXXXII . *Production of Radio Receivers*

Year	Production
1956	150,600
1957	190,602
1958	198,108
1959	213,868
1960	325,908
1961	326,340
1962	348,084
1963	358,000
1964	413,000
1965	512,000

For telephone industries, India is no longer dependent upon foreign sources as the Indian Telephone Industries Ltd., and the Posts and Telegraphs Department are now able to meet the entire demand of the country. Established in February, 1950 with an authorised capital of Rs. 2.5 crores, the Indian Telephone Industries turns out about 40,000 instruments annually.

Besides, considerable progress has been made in regard to the production of other electrical gadgets. The monthly rated capacity and average output of Dry cells have increased from 110 lakhs and 73 lakhs in 1947 to 191 lakhs and 132.4 lakhs with six modern factories currently engaged in the line, while the corresponding figure for storage batteries are 14,300 and 2,300 in 1946 and 24,200 and about 20,000 presently with 13 units in the sphere.

QUESTIONS

1. Discuss fully the geographical and economic factors that favour the development of Electrical industry in India.
2. Write an essay on the future of electrical industry in India.

CHAPTER 27

Textile Industries

As the premier organised industry of the country, the Indian Cotton Textile Industry, of its own right, occupies a pivotal position in the nation's economy. The industry's paid-up capital is of the order of Rs. 110 crores and its annual turnover amounts to over Rs. 400 crores. After agriculture, it is the most imporrant single source of livelihood to the country's working population, over 750,000 workers being employed in over 500 mills. As stated at the very ouset its premier position among the organized industries of the country is borne out by the following figures showing the number of workers engaged in the various industries of the country.

Industry	No. of workers employed in major Industries (000)
Cotton mill Industry	755
Jute Textile	267
Basic metal industries	85
Sugar	77
Electric machinery *etc.*	25
Cement	13
Woollen Textiles	11

In short, it is difficult to accurately gauge the quantum of total benefit that has been accruing to the country from the functioning of this industry. In the matter of employment alone, something like a fourth of the total working population in organised industries numbering a little over thirty lakhs is finding lucrative employment over and above, a large body of men comprising the technical, administrative and clerical personnel who are also making their living out of it.

Over a score of industries manufacturing the various requirements of the mills have since come into existence and a substantial beginning has been made in the manufacture of heavy textile machinery. Some hundreds of thousands of persons, most of them having very small holdings, have invested their savings in the industry. Above all, millions of agriculturists all over the country are dependent for their living on

the cultivation of cotton which supplies the greater part of the requirements of the mills. Besides, the industry is the main prop of the handloom weaver and the vast numbers engaged in the cotton yarn and cloth trades and in the manufacture and sale of textile auxiliaries. In fact, the industry touches the economic life of the community at so many points that it is almost impossible to assess the actual number of people directly or indirectly benefitted by this industry.

Textile industries include (1) Cotton textiles industry including cotton yarn, cotton cloth *etc.* (2) Jute textiles (3)Rayon and (4) Woollen manufactures *etc.*

COTTON TEXTILE INDUSTRIES

Historical Development

Though the first cotton mill (Bowreah Mill) was started at Calcutta in 1818 the industry may be said to be really born in Bombay in 1854. The cotton textile industry is by far the most important manufacturing industry in India. This is known by the fact that of the average daily number of workers employed by different manufacturing industries in India in November, 1960, about 9 lakhs were employed in cotton mill industry. This was the largest number employed in any single industry. Hence the basic importance of the cotton industry to the well-being of the people can be easily gauged.

Localization Factors

The localization of the cotton mill industry depends upon many factors, such as the supply of raw material, fuel, chemical, machinery, labour, communications and market. Any of these factors may determine the location of this industry, provided it gives a decided advantage in competing against other locations of this industry. Thus, Lancashire in England does not produce any raw cotton, nor does it enjoy locally any considerable market for the products of cotton mill industry. But it commanded, through political control, a vast market in commonwealth countries. This one factor led to the tremendous development of the industry there. The ease with which raw cotton can be imported from U.S.A., and the nearness to coal-mining areas, which supplied not only fuel and machinery but also cheap labour of women and children from the families of miners and workers in iron works, were all secondary advantages. Similarly, the access to the Indian and other neighbouring markets was an incentive to the development of this industry in Japan. Japan also does not produce any raw cotton. It imports most of it from India. The vast supplies of cheap labour, and cheap ocean transport together with Government support in various ways helped the development of cotton industry in Japan.

In India, the localization of the cotton mill industry has been brought about chiefly by the following factors :—

(a) supply of raw material;

(b) ease of importing machinery and mill stores from abroad; and

(c) the vast market.

Supply of coal has not played any important part in locating cotton mills. For the amount of coal needed by the mills is negligible when compared with the vast amounts of raw cotton, finished goods or machinery that have to be moved. Climate also does not play any direct part. For artificial humidity supplied to the spinning rooms controls the moisture conditions of air quite efficiently without much cost.

Towards the earlier part of 1962 there were 480 cotton textile mills (195 spinning and 285 composite) in India, with 13.83 million spindles and about 2 lakh looms. Nearly Rs. 122 crores were invested in the industry and about 8.9 lakh workers employed at the beginning of 1961.

The following table shows the growth of Cotton mills in India :—

Year ending 31st August	No. of Cotton mills	No. of Spindles installed (in million)	No. of Looms Installed	Average No. of workers employed daily	Cotton consumed in million bales of 392 lbs. each
1938[1]	380	10.02	200,886	437,690	3.66
1947[1]	423	10.35	202,662	488,370	3.97
1948	408	10.26	197,419	466,477	4.20
1950	425	10.85	199775	433,816	3.79
1952	453	11.43	203,786	432,588	4.13
1954	461	11.89	207,763	435,421	4.69
1956	465	12.37	206,580	789,024	4.99
1958	511	13.71	205,598	775,865	4.64
1959	516	13.53	205,973	884,628	5.07*
1964	517	15.30	205,468	846,833	5.50*

The greatest advantage possessed by the Indian cotton industry is the extent of the home market. The significance of this advantage can be realised from the fact that for the two countries from which India drew practically the whole of the imports of manufactured cotton, *i.e.*, Great Britain and Japan; she represented the largest single export market. An idea of the enormous extent of the Indian market can be gathered from the fact that, although imports into India in 1931 did not represent in quantity more than 15 p.c. of the total con-

1 Relate to undivided India.

* of 400 lbs. each.
+ 180 kg. each.

sumption of cloth in the country they represented for each of the above two countries the largest single line of export.

The largest centres of cotton industry in India are where raw cotton is abundant. Bombay obtains the raw materal from stocks brought to Bombay for export, as practically all the raw cotton is exported through it. It has also the advantage of importing machinery and mill stores from abroad easily.

Bombay and Ahmedabad are the principal centres of the industry; about one-third of the total number of mills in the country are at these two places now. Elsewhere in the country, the cotton mills are scattered whereever facilities of raw material are available. In the cotton mill industry, market and the raw material play the most important part.

The following table gives the distribution of cotton textile industry as in August, 1965 in India :—

TABLE CXXXXIII. *Distribution of Cotton Textile Industry*

State	No. of Mills	No. of Spindles installed	No. of looms installed	Average no. of workers employed	Consumption of raw cotton (in bales of 180 kg.)
Andhra Pradesh	19	289,152	1235	14,596	13,764
Assam	2	22,600	—	1009	1020
Bihar	4	47,432	809	2039	918
Gujarat	104	3186,595	59,183	185818	100,307
(a) Ahmedabad	67	2306,229	44,578	166,199	70,534
(b) Rest of Gujarat	37	880,366	14,605	49,619	29,773
Kerala	18	280,000	1,040	9,975	7650
M. P.	18	540,791	12,605	43,438	28,689
Madras	154	3528,949	8,642	112,229	91,357
Maharashtra	84	43745,916	81,170	270,823	154,663
(a) Bombay	57	3382,552	63,047	212,858	123,401
(b) Rest of Maharashtra	27	993,364	18,123	57,965	31,262
Mysore	22	548,470	5,346	32,496	19,849
Orissa	4	93,000	866	6,531	4296
Punjab	11	232,481	2,187	13,780	16,146

Rajasthan	13	250,594	2,525	14,078	15,947
U. P.	25	888,837	13,589	63,801	45,131
(a) Kanpur city	11	533,872	10,983	45,421	27,486
(b) Rest of U. P.	14	352,965	2,606	18,380	17,645
West Bengal	31	758,974	10,199	48,030	29,321
Delhi	4	177,628	3,814	20,565	16,119
Pondichery	4	89,064	2258	7,625	5467
Total	517	15310,474	205,468	846,833	550,647

Location of The Industry

The location of cotton mill industry is influenced by factors other than the proximity of raw material. There is no material difference between the cost of transporting cotton and cotton products and hence the industry often tends to be located at centres with favourable transport relations to markets. To use Weber's terminology, the material index for this industry is not much greater than one. Bombay Island has always been the chief centre of cotton mill industry in India. It has less than two-thirds of the total number of the workers employed in the Cotton Mill Industry of India, followed by Madras, U.P., M.P., and Bengal, *etc.* The most notable feature of the distribution of the industry is that even within the State the industry is localized within particular areas and regions, almost to the complete seclusion of others. Thus, in Madras and Andhra the industry is mainly localised in the districts of Coimbatore, Madurai and Tinnevelly while other districts like Nellore, Vishakhapatnam, Chittoor, Cuddapah and Tanjore have relatively very small share in the distribution of the industry. Similarly, in U.P., the industry is located in the western districts of Agra, Aligarh, Kanpur; almost to the complete seclusion of the Eastern districts. In Bengal, the industry is mostly localized in the districts of Hooghly, 24 Parganas and Khulna. It is significant to note that even within these particular areas or regions, the industry is predominantly localized within a few important industrial centres like Bombay, Ahmedabad, Sholapur, Baroda, Poona, Kanpur, Delhi, Indore, Gwalior, and Coimbatore, *etc.*

There are several reasons which explain and account for initial concentration of the Cotton Mill Industry in and around the City and Island of Bombay. These reasons are :—

(i) The leading Parsi and Bhatia merchants of Bombay, acquired vast financial resources from the cotton and opium trade with China and the export of raw cotton during the American Civil War. These funds were utilized in the cotton mill industry. The intimate knowledge and control of cotton trade enabled these merchants to exercise personal control over details of the working of cotton mill companies and the

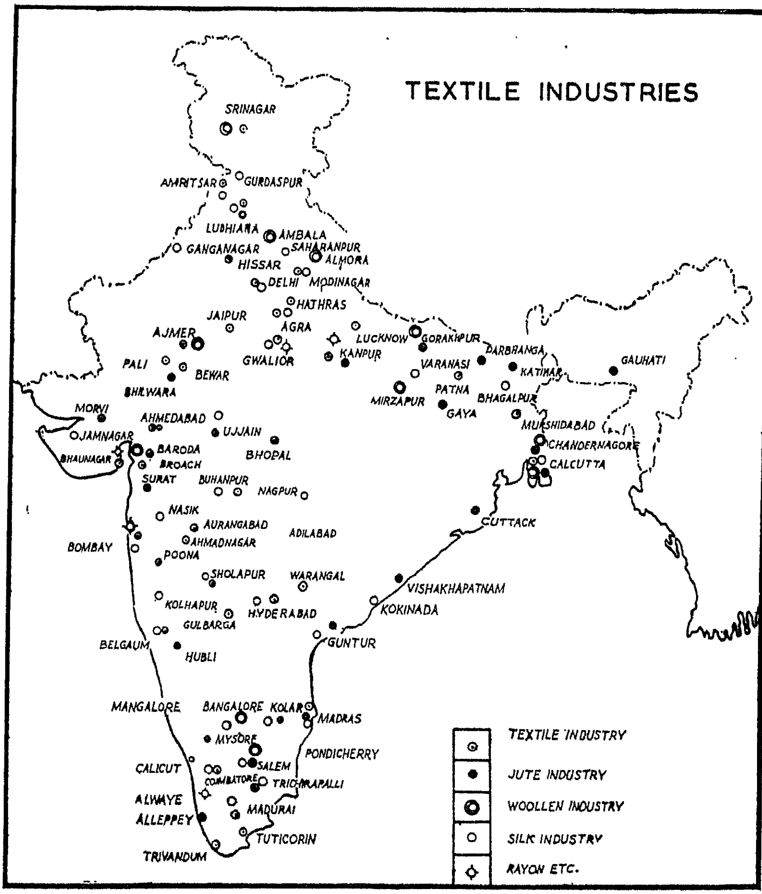


Fig. 61. Important Textile centres in India

technical skill and experience was made available by the machine-making firms of England. The local agents of these firms arranged for importing, along with machinery, skilled and technical labour from Lancashire not only to fit up and supervise machinery but also to manage the mills using their machinery.

(ii) The supply of raw cotton for the mills was available from the cotton-growing tracts of the country. As Bombay was the leading port of export of raw cotton, the coton crop not only of Bombay State but also of the neighbouring regions gravitated in large quantities to this port for export and a special flow of cotton to Bombay to feed its new cotton mills had not to be created.

(iii) Owing to the absence of chemical and engineering industries in India, mill-stores, machinery and other accessories had to be imported from abroad, but owing to the insular position of Bombay, it enjoyed the advantages of cheap sea freight on imported articles, especially from England.

(iv) Bombay, being the important junction of main railways, was also connected with the interior markets not only of raw cotton but of piece-goods too. The policy of railways to charge lower freight-rates from and to the ports increased the transport advantages of Bombay over other inland towns. Thus in spite of its producers' buying markets and consumers' markets being situated at long distances, Bombay Cotton industry enjoyed especially favourable transport facilities.

(v) For the supply of unskilled labour Bombay depended upon the coastal districts of Konkan, Satara, Ratnagiri and other parts of Bombay Deccan. Gradually workers were also attracted from distant regions like Rajasthan, West U.P., Madhya Bharat *etc.*

(vi) The humidity of Bombay was also a climatic advantage for the spinning of cotton thread.

Thus a fortuitous combination of all these factors led to the initial concentration of cotton mill industry in Bombay and consequently Bombay became an excellent site for the pioneer cotton mills of India. So that at the end of the 19th century Bombay alone represented more than half the installed capacity of the whole of India and inspite of a few mills here and there this island city with its 82 cotton mills could justly be called the "Cottonopolis of India".[1]

But after 1921, the dispersal of the industry set in. This process was specially rapid after the enervating depression in the Bombay textile industry which started in 1923 so that there was a relative decline in the predominant portion of Bombay and a relative increase in the industrial activity in the more and more interior regions.

This change has been due to the appearance of deglomerating tendencies which act against local concentration. These tendencies began as a result of : (i) increase in the land values and rents because of lack of area available for sites on the island; (ii) rise in the cost of living due to scarcity of consumption articles because of the separation of the mainland of Bombay by the Western Ghats; (iii) increase in internal cost of transport; (iv) increase in rates, taxes, town duty, water charges, *etc.*, and lastly (v) the change in the nature of consumers' markets and production. So that Bombay lost the advantages of special transport relation and with the gradual economic development of the interior regions, the conditions for the establishment of cotton mills became more favourable and inviting.

---

1 T. R. Sharma, *Location of Industries in India*, p. 17.

The causes responsible for the dispersal of the productive activity in the cotton mills industry may be analysed thus : The initial dispersal of the industry was due to the development of the means of transport and communication in the interior regions. With the penetration of the railways in the interior, many new centres sprang up. Many of these centres like Coimbatore, Madura, Bangalore, Nagpur, Indore, Sholapur and Baroda were favourably situated both in regard to raw materials and the consumers' markets than the places of original locations. As they were situated in the heart of the cotton-growing tracts as well as near the consumers' markets, they offered the possibility of saving double freight on raw cotton as well as finished goods with regard to foreign competition, the mills in the interior could also enjoy at least partial protection in their local markets to the extent of saving the railway freight from the ports to the internal markets. Hence, new cottn mills sprang up wherever capital and organizing ability were available.

The earliest development of the cotton mill industry outside Bombay city took place at Ahmedabad, where the financial facilities and the entrepreneurial ability were in no way inferior to those at Bombay and where the mills were situated in the midst of the cotton-growing districts of Gujrat and Saurashtra. It is the only centre in India which resembles the great cotton centre of Manchester situated in Lanchashire region and probably for this reason it is called 'The Bolton of the East'[1], and where Broach and Dholeras—the two important varieties of cotton predominantly used here[2] are grown and its nearness to the sea enables it to import foreign—the East Africa and the Egyptian cotton—easily, and the machinery and the mill-stores from abroad. The spinners and weavers required for the industry were drawn from a class of people whose ancestors carried on hand spinning and weaving before machinery came into use. The finished products could be conveniently distributed in Gujarat, Saurashtra, U.P., E. Punjab, M.P. and Rajasthan, because of its railway connection.[3] In equally favourable conditions the cotton industry reached certain other centres like Sholapur, Hubli.

Besides the advantages of local supplies of raw materials cheap labour, and regional consumers' markets the cotton-growing tracts of Madhya Pradesh had an additional advantage of having the remarkable coal-mines within the state. Sri J. N. Tata realising the importance of this region decided to locate his mills at Nagpur. The town was situated in the cotton-growing tract; it was the terminus of the Western Rly., it was within reach of supplies of coal from Warora mines and it was the chief market for many miles around. It was also the centre of a large handloom industry ready for the products of Tata's weaving

1 T. R. Sharma.
2 Report of the Bombay Textile Enquiry Committee, (1927-38), p. 70.
3 Report of Indian Tariff Board (1927), Vol. II p. 390.

mills. Land was also cheap, agricultural produce abundant and the distribution of the manufactures could easily be facilitated owing to the central position of the town.

The first up-country mill was located outside the peninsular India—on the edge of the cotton growing region of the Indo-Gangetic plain at Kanpur. Owing to its favourable geographical situation large quantities of cotton passed through Kanpur and on account of its being an important trading centre it possessed excellent financial facilities, while cheap labour was provided by the thickly populated areas in the vicinity. It had very good location for obtaining the supplies of good coal from Bengal and Orissa.

Though West Bengal lies away from the cotton growing belts of the country, yet on account of favourable situation of the port of Calcutta for importing raw cotton, mill-machinery and stores, the nature and extent of wide market in the neighbouring states of Assam, Bihar, Orissa, Manipur, Tripura, *etc.*, along with the supplies of good coal within the state itself, it was found practicable to set up cotton mills in West Bengal. Here the climate also favours the use of cotton clothes throughout the year.

The development of the hydro-electric power in the country has also favoured the dispersal of the industry. The extraordinarily rapid expansion of the spinning industry in the Madras state—particularly in Coimbatore, Madura and Tinnevelly was greatly assisted by the completion of the Pyakra Hydro-electric scheme, and the readiness of the local industrialists to take advantages of the new sources of power. Similarly, the expansion of the Singarapet was greatly helped by the construction of the Mettur Stanaley Dam. The completion of the Papanasam Hydro-electric scheme also helped the expansion of the industry in Tuticorin, Kovilpatti, Madura, Ambassamudram, *etc.* The future development of water power will further lead to a wider dispersal of the industry.

The industry has also shifted from regions of high costs to those of low labour-costs. In cotton textile industry wages form 20 to 27 per cent of the total costs or 40 to 54% of the total work cost; depending, on the productivity of labour, level of wages, and the character of output. The wages are high in centres like Bombay, Ahmedabad, Delhi, Baroda, Indore, Kanpur and Madras, *etc.*, and they are lowest in Kerals, Ramnad, Tinnevelly, Salem, Trichinopoly, Pudukota, *etc.* Hence, new cotton mills after 1933 have been located in centres like Madurai, Tinnevelly, Coimbatore Ramnad, Salem, Sholapur, Barsi, Gohak Dhulia, Amalner, Jalgaon, Ka'ol, Poltad, Nadiad, Ujjain, Beawar, Agra, Hathras, Broach and Bangalore.

The new mills in the interior have captured the markets of Bombay and Ahmedabad for coarse materials in their own areas and have thus forced these centres to change the nature of their production. The city

of Bombay has gone to fine and Ahmedabad has gone to finer still and is leading the whole of the Indian industry in this respec . From the point of progress in qualit Ahmedabad resembles what they call in Lancashire the Egyptian section of the cotton industry while Bombay the 'American section of the British Cotton Industry'.

Production

As is characteristic of the region where the raw material is abundant, production of yarn exceeds that of cloth in India. Most of yarn spun is coarse, mostly below 30 counts. In 1931-32, 88 p.c. of the yarn spun in India consisted of counts 1 to 30s.; and only 3 p.c. of counts above 40s. This is due to the short and coarse staple of the raw cotton produced in India. Even the so-called long staple cotton in India, taking warp and weft yarn together is, suitable only for the manufacture of yarn of counts 24s. to 40s., for all the long-staple cottons in India do not have the required degree of evenness and strength. The Punjab-American crop represents the largest proportion of long-staple cotton in India, but about four-fifth of this is sold by the cultivator mixed with Deshi cotton. For the production of yarn of higher counts than 40s. no suitable raw cotton is available in India.

Finer yarn is spun in Ahmedabad and Bombay from cotton imported from Egypt and the United States of America. During the War, there was a considerable increase in production, *e.g.*, the production of cloth rose to about 4,800 million yards in 1943-44. But owing to shortage of coal the production could not be raised further. The growth in recent years is shown below :—

TABLE CXXXXIV *Cotton Mill Production*

Year	Yarn in 000 Kg.	Coarse	Medium B	Medium A	Fine	Superfine
			000 metres			
1960	787,959	644,254	1,589,706	1,897,106	209,421	275,719
1961	862,294	790,162	1,527,564	1,986,345	179,325	218,046
1962	859,563	760,778	1,403,866	1,946,346	196,660	252,604
1963	892,574	809,750	1,320,991	1,807,914	204,257	279,946
1964	964,819	868,474	1,475,272	1,807,974	195,035	306,754
1965	129,200	..	..	..	..	..

The total quantity and value of different types of cotton textiles produced in 1957, is as follows—

Coarse	..	1,164 million yards	Rs. 58 crores
Medium	..	3,503 ,, ,,	,, 210 ,,
Fine	..	383 ,, ,,	,, 38 ,,
Superfine	..	263 ,, ,,	,, 31 ,,

About 80 p.c. of the cloth manufactured in India, is now of medium or fine quality. The imported cotton from the U.S.A. accounts for the increasing amounts of better quality of cloth produced in India.

India is now one of the largest producers of cotton textiles in the world, and the largest in Asia. Her progress was particularly marked during the second World War.

The production of cotton cloth and yarn was 4927 m. yds. and 1685 m. lbs., in 1958. The reduction was due to higher labour cost; a high level of taxation and obstacles coming in the way of modernisation.

In 1960 the production of cotton cloth and yarn was 5048 m. yds. and 1710 m. lbs. respectively and in 1961, 5127 million yards and 1887. 5. million lbs. respectively. The corresponding figures were 4988.3 m. yds. and 1892.9 m. lbs.

Under the Third Five Year Plan total output of mill-made cloth was from 5127 million yds., in 1960-61 to 5800 million yds., in 1965-66 and the capacity from 5300 million yds., to 5800 million yds. The expansion in the capacity and output of cotton yarn was proposed from 2100 million lbs. in 1960-61 to 2250 million lbs. in 1965-66 and 1750 million lbs. in 1960-61 to 2250 million lbs. in 1965-66 respectively.

Country	1958 Spindles (Million)	1958 Looms (Thousand)	Cloth (yds.) in
U.S.A.	26	350	9.539 million
U.K.	20	252	1,628 ,,
Japan	9	380	3,706 m. sq. yds.
India	13	205	5,317 m. yds.

EXPORT

The export market for our cotton industry is very small. Our chief markets are the countries where the Indians have settled in large numbers. The most valuable markets are South and East Africa, Iraq, Persia and ceylon. Bombay does the largest export trade.

In 1955, we exported 836 million yards of cotton cloth to foreign countries and 854 m. yds. in 1957 of which coarse cloth amounted to 176.6 milion yds. and 233.8 m. yds.; medium cloth 602.6 million yds.; and 590.8 m. yds. fine 35.8 million yds. and 12.0 m. yds.; and superfine 21.0 million yds. and 17.3 m. yds. The main varieties which we export consist of sheetings, long cloth, shirtings, coatings, voils, mulls and chintzes.

In 1959, 816 million yds. of cloth was exported to Foreign countiers which was valued at Rs. 54 crores and in 1960 (Jan. to Nov.) 590 million yds. of cloth was exported, the value of which was Rs. 49 crores.

The Indian delegation to the World Textile Conference expressed India's desire to export 1,000 million yds. of cloth per annum.

Besides cloth, cotton twists and yarns are exported to Burma, Straits Settlement, Syria, Aden, Thailand, Iraq, Arabia, and other countries where Indian immigration is considerable.

There has been a continuous decline in our export of Cotton textiles. In fact, exports during 1962 were the lowest during the last ten years. The following table gives the sea borne export trade of all cloth.

TABLE CXXXXV : *Export Trade of Cloth*

Year	Twist and Yarn		Cloth	
	Million lbs.	Rs. in Crores	Million yds.	Rupees in crores
1958	31.61	5.80	581.0	40.00
1959	24.32	4.37	850.8	59.00
1960	14.20	3.70	604.83	54.70
1961	15.00	3.73	575.00	46.17
1962	23.00	5.30	508.36	39.16
1963	30.00	6.20	531.15	41.02
1964	27.00	5.84	554.00	44.30

Although all possible efforts are being made to boost our exports, we have to face many practical difficulties particularly as a result of the keen competition in the foreign markets from textile-producing countries like Japan and China. The important policies of foreign countries have also become more and more restrictive. Until recently our exports have been mostly of coarse and medium varieties and the markets for these are somewhat limited. In spite of these discouraging factors, cotton textiles will continue to be one of our major foreign exchange earners and efforts to increase exports will continue to be made during the Fourth Plan Period.

There is a great future for this industry in India as the standard of living is rising. At present the average of cotton cloth in India works out at about 12 yards per head. This is very low when compared with 64 yards which is the average for U.S.A. To raise the consumption of cloth to any decent figure in India will require a tremendous growth of the industry and at the same time the purchasing power of the people.

Cotton mills at present suffer from the following difficulties :—

(i) Though the Post-war Planning Committee estimated that the optimum size for a composite mill is 25,000 spindles and

600 looms, but unfortunately a large number of composite mills as well as spinning mills are below the economic size. According to the estimates of the working party on cotton mills industry some 150 mills are uncommercial.

(ii) A large number of mills have worn out and obsolete machinery. The Bombay Millowners' Association estimated that nearly 90% of the machinery in Bombay mills is more than 25 years old. Hence, the existing mills should be brought to the economic size and the machinery and technical equipment should be renovated and modernized.

(iii) In spite of growth of industries in other parts of the counry such as Madras, M.P., U.P., the industry still continues to be concentrated in Bombay where 60% of the existing spindles and looms are installed. Hence, mills should be properly located.

Features of Export trade

The important features in our exports of cotton textiles are :

(a) About 90 to 92 per cent of our total exports consists of coarse and medium counts of cloth;

(b) An overwhelming percentage of our total export of cloth is in the grey form which gets processed in the importing countries for purposes of re-export.

(c) A bulk of our exports are to countries in Asia and Africa;

(d) Comparatively very little percentage of our exports are in dyed or printed and in other processed forms.

The Government of India have been earnest in promoting exports of textiles produced in this country and have already taken certain steps. Some of the important steps taken are :

1. Constitution of the Cotton Textiles Export Promotion Council for intensive study of market conditions abroad cotton textiles and to promote exports;
2. grant of rebate of excise duty on goods exported;
3. assistance to manufacturers and exporters in obtaining raw material required for producing goods meant for export in good time and at fair prices;
4. popularising of commercial arbitration for settlement of trade disputes;
5. introduction of quality control measures and inspection schemes in regard to textiles intended for export; and
6. participation in international exhibitions and maintenance of trade centres and commercial show-rooms at important centres of the world.

Some further measures which are considered necessary to enable manufacturers to improve the quality of the fabrics produced are also being actively considered.

Problems of the Industry

Amongst the important problems facing the industry are :

(1) Replacement of the old machinery by new equipment;

(2) Reduction of cloth and yarn prices to stimulate higher consumption;

(3) growing competition in textiles in the export market;

(4) heavy incidence of taxes and levies and more particularly excise duty and sales tax on mill cloth;

(5) low productivity of workers and a mounting wage bill;

(6) Inferior quality and shortage of cotton.

The probiem of raw cotton supply is a new problem which faces this industry due to the partition of the country. The amount of raw cotton produced in the Indian Union is not enough for the home needs. Raw cotton has, therefore, to be imported from Pakistan and other countries.

It is incontrovertible that much of the productive equipment of the industry is old, worn out and outmoded and that it is in urgent need of replacement and modernization. But modernization of the industry as a whole cannot be effected overnight for the simple reason that the cost of new machinery has gone up considerably. But the Indian industry has either to modernise or stagnate and collapse in the face of Japan's competitive strength which lies in the fact that her industry is rationalised and modernised.

Over 65 percent of Japan's textile plants and machinery are brand new, a very large proportion of looms installed in the postwar period are automatic and there has been a rapid advance in the scientific apportionment of workloads amongst the workers. For example the average number of ring frames looked after by one Japanese worker is about four to five that is, 699 to 2000 spindles Similarly, the average number of looms minded by one weaver is 30 to 40. A similar tendency is also noticeable in Britain and the United States, the two other leading textile manufacturing countries.

If the Indian textile industry is to hold its own in the race for export market and to export 1000 million yards of cloth per year, she must make an all out efforts to increase productivity and reduce the cost per unit of cloth and this can only be done by modernization and rationalization.

COTTON HANDLOOM INDUSTRY

Hand-spinning and hand-weaving have been India's traditional village industries. The spinning wheel was being universally plied in most Indian homes. Even today it is one of the important cottage industries of the country. According to the Fact Finding Committee, 1942, the number of weavers were about 2.4 millions besides about 3.6 millions besides about 3.6 million auxiliary workers; thus giving a total of 6 milion weavers for undivided India, for 2 million working handlooms, and the value of handloom production was estimated at 72.80 crores of rupees. Even after partition, handloom weaving industry is still an important industry, in fact the largest and the most widespread after agriculture. This industry now provides employment to 14 million people and produces about one-third of the total production of cotton cloths and has about 23,26,000 handlooms. The annual production in 1965-66 was over 25250 crore metres.

The yarn needed by the industry is supplied mostly by the mills. It is only weaving that is generally done in these small towns. In some cases, however, yarn used is also handspun. Cotton is distributed to women-folk in the surrounding villages where it is spun and then brought to the town to be woven.

With the improvement of the handloom in recent times, the equality of the goods produced on the looms has considerably improved. Such improved quality goods enter successfully into competition with mill products, and give employment to thousands of workers.

In India both the coarse and finer qualities of goods are made by handlooms. Napkins, gauze, bandages, jaconet, bed-sheets, table cloths, curtain cloths, bordered saries, and cloth of coarse type are usually produced on the handlooms. One of the reasons why the hand woven cloth is more popular than machine-woven cloth is the variety of the patterns which can be produced on the hand-made article. Muslims wear plaids which are of infinite variety while borders are common on Hindu men's and figures on Hindu women's clothing. Hand weaving supplies this demand in an endless selection of patterns.

Producing Centres

Important centres for the cotton handloom industry in India are Banaras, Gorakhpur, Tanda, Etawah in U.P., Chanderi in M.P.; Nagpur, and Poona in Maharashtra; Bhagalpur in Bihar; Shantipur in Bengal; Kozhikhode, Madras, Madurai, Coimbatore and Karnataz in S. India; Govindagarh and Chomu in Rajasthan.

Cotton handloom weaving is the largest and the most important cottage industry in Assam. Handloom industry is the most important industry in Manipur and Tripura. The industry is, of course, the most important all over the country. In cotton handloom industry, the pro-

ducts worth mentioning are: Sarees, *pattu*, paltin carpet, Shawls (pashmina) dhoties, towels, sheetings and coatings. Carpet-making is also a flourishing industry in Badoi, Jagadhari, Srinager, Agra, Sitapur, Almora, Jaipur, Patiala *etc*.

Production

Production of handloom cloth in the country during 1958-59 was estimated at 1865 million yards. Production in 1959 was 1880 million yards. The following table shows the production of handloom since 1950.

TABLE CXXXXVI : *Production of handloom cloth in India*

Year	(in million Yds.)
1950	805
1951	850
1952	1,109
1953	1,200
1954	1,318
1955	1,480
1956	1,509
1957	1,714
1958	1,865
1959	1,880
1960	1,700
1965-66	2,525

According to the estimates of the Village and Small Scale Industries Committee, the additional quantity produced in handlooms was as much as 17,000 million yds. by the end of 1960-61. It is proposed to increase the number of handlooms in the cooperative field from 1 million to 1.45 million by 1963-64. It is also proposed to introduce technical and other improvements, thus raising the production per unit from about 4 yds. to about 8 yds. a day.

Exports

The export of handloom cloth in 1958 amounted to more than 35 million yds. valued at about Rs. 5.23 crores. Ceylon was the most important importer of Indian handloom piecegoods importing 40% of the total Indian export of handloom cloth. Other major importers were Malaya, Nigeria, Singapore, Aden, U.K., Sudan and Ethiopia and the U.S.A.

RAYON INDUSTRY

Historical Development. Rayon is the result of man's effort to imitate silk. For thousands of years silk was the raiment of royalty and nobility because of its rarity, brilliance, fineness and constliness. Rayon is the first man made fibre to satisfy this understandable human hankering for showiness and as such it is the outstanding technological development in the textile field since the mechanical inventions that ushered in the industrial revolution. In 1664 a young English physician wrote about the possibility of a chemical substitute for natural silk. During the next two hundred years, dozens of others made similar comments but the project never got beyond the speculative stage. Finally about 1850, active experimentation began and by 1900 four district methods of imitating silk had emerged.

The first nitrocellulose process was patented by Count de Chardonnet. He was a student of Pasteur when the great French Scientist was evolving a cure for a silk worm disease which threatened to wipe out the silk industry of France. Two years later, the English investigators, Cross and Bevan, announced what is today called the viscose process. In 1893, Cross also patented the recently popularized acetate process. Finally in 1889, the present-day cuprammonium method was successfully commercialized in Germany. Today the Viscose and Cuprammonium process products go under the name of Rayon whereas cellulose acetate is known differently.

Raw Materials

The rayon industry, as it has developed at present, is predominantly based on imported raw materials—the most essential materials being dissolving pulp, cotton linters, rayon grade caustic soda and sulphur. While it may be difficult to attain self-sufficiency in sulphur, plentiful materials are available in the country to produce all the pulp, linters and caustic soda that the industry needs. Efforts should, therefore, be made to strengthen the base of the rayon industry by establishing a plant for the manufacture of pulp and a few units for producing cotton splinters.

Producing Centres

Though Rayon had been consumed in substantial quantities in India for the manufacture of art silk fabrics, particularly during and after the World War II, efforts to manufacture it started only in the post war period. There are at present four factories out of which the National Rayon Corporation Ltd., Kalyan, Bombay and the Travancore Rayons Ltd., Perumbvoor, Trav. Cochin manufacture viscose filament yarn while the Gwalior Rayon Silk manufacturing Co., Ltd., manufacture Viscose Stable fibre and the Sirsilk Ltd., Hydrabad manufacture acetate filament yarn.

Production. During 1959, four units were engaged in the production of continuous filament viscose rayon yarn, with an aggregate installed capacity of 17,800 metric tons, actual output was15,074 metric tons. The following table shows the production of Rayon yarn in India since 1950-51.

TABLE : *Production of Rayon Yarn*

Year	Production (000 tons)
1950-51	2.1
1955-56	13.5
1960-61	43.8
1961-62	52.1
1962-63	62.1
1963-64	67.9
1964-65	72.2

FIBRE

Rayon filament yarn is used for the manufacture of many types of fabrics and is also used in manufacturing hosiery and knitted goods, gas mantles, embroideries, automobile types etc.

The staple fibre factory of Gwalior Rayon's started production in 1954 with a capacity of 5400 tons per year. The South India a Viscose has a capacity of 4,000 tons per year.

The consumption of rayon filament on the basis of production plans imports from 1957-58 to 1962-63 is estimated as under—

	Million lbs.		
Year	Production	Imports	Availability
1957-58	26.6	40.9	67.5
1958-59	35.0	44.5	79.5
1959-60	38.0	39.7	77.5
1960-61	47.0	32.0	79.0
1961-62	51.8	36.3	88.1
1962-63	63.9	27.8	91.5

At the start of the Second Plan, Messrs. Gwalior Rayon Silk Manufacturing (weaving) Company was the only factory producing staple fibre. Its plant at Nagda had a capacity of 16 million lbs. per annum at that time. The production of Staple fibre during 1960 to 1964 is given below—

	(000 tons)	
Year	Installed capacity	Production
1960	21.60	21.78
1961	25.20	26.00
1962	26.04	32.38
1963	26.04	32.24
1964	26.04	37.48

Exports

Exports of Silk and Synthetic fibre which rose to a peak of 90.5 million metres (Rs. 10.35 crores) during 1963 declined to 64.75 million metres (Rs. 7.94 crores) in 1964. The principal buyers were Malaysia, Ceylon, Hongkong, Aden and Afghanistan.

Historical Development. Jute is the head of the family of fibres and also the toughest of them all, and as an industrial fibre, it has unrivalled qualities as a packaging material for the heavy work of trade and industry. The beginnings of the jute industry were clouded with doubts and hesitations. Originally a handloom and largely cottage occupation, the production of Chuttees, that is, lengths of cloth for making bags, reduced its high-water mark around the middle of the nineteenth century. Though Indian hand-made jute cloth enjoyed a market in three continents, the value of the total export trade in 1850-51 did not exceed more than Rs. 21 lakhs. The first power-driven factories began to function in Dundee about 1833 demonstrating that the machine-made articles had considerable advantages over the local Indian product.

The advent of power-driven machinery in Dundee and later on in rialcutta in 1855 undoubetedly spelt the doom of the handloom jute fab-Ccs. Be that as it may, as a manufacturing centre, Calcutta, in close proximity to the sources of high quality raw material obviously possessed natural advantages denied to Dundee. Thus Calcutta soon eclipsed Dundee in the production of machine-made jute fabrics. To George Auckland and Syamsunder Sen, gocs the credit for establishing Indian first power-driven jute spinning unit at Rishra on the Ganges, a few miles from Calcutta. Here in 1855, with machinery imported from Dundee the first ever Indian jute mill went into production with an output of eight tons a day.

From such humble beginnings, the Indian Jute industry has developed into India's largest dollar earner as also the premier Jute manufacturing industry in the world. Now its products occupy the highest place in India's export trade, earning the largest quantum of dollars, supplying as it does the greatest amount of packaging material to the trade and commerce of the world. Even though these superlatives still stand, the foundations of India's Jute industry sometimes seem to be

shaky and in recent years, the importance of Jute goods in India's balance of trade has been increasingly a cause for concern rather than for complacency.

After cotton textile industry the most important industry is jute. In 1959 there were 113 mills. The Industry has a capital of 65.3 crores and gave employment to 271,415 persons. This industry is still predominantly localized in West Bengal. It is particularly striking to note that raw jute which is the chief raw material of this industry is a "pure raw material" as it imparts its full weight to the finished product. The loss of weight in the process of manufacture is almost negligible, in fact much less than in the case of raw cotton. The location of industrial unit need not be near the sources of raw material. Nevertheless, the excessive concentration of the jute mill industry in the Hooghly Riverian region can be attributed to the combination of various factors :—

(i) Bengal occupies a unique and unrivalled position as producer of raw cotton jute, for it accounts for 90% of India's output of raw jute. The rich alluvial soil and the humid climate of Mymensingh, Tiperrah and Faridpur are exceptionally suited for the production of raw jute.

(ii) The net-work of waterways, which connect the most important jute-growing regions of West Bengal, offer favourable facilities for assemblage and transportation of raw jute from centres of production to centres of manufacture. The Ganga, the Brahmaputra, the Meghna along with their tributaries provide the cheapest form of transport for the movement of jute fibre from fields to the factories.

(iii) The proximity of coal deposits has been a material consideration—as it can be cheaply had from mines of West Bengal and Orissa, etc. The distance of Raniganj and Asansol coalfields is only about 120 miles.

(iv) The earlier concentration of the industry in and around Calcutta could be ascribed to the availability of British, mainly Scottish enterprise and capital—both of which played a very great part in the development and expansion of jute mill industry.

(v) The insular position of Calcutta offered additional advan tages to the jute industry in regard to foreign markets. Besides, mill stores could also be imported from abroad. easily.

(vi) It is worth noting that Bengal did not provide necessary labour for the jute industry. It was drafted from Bihar, Orissa, U.P., and even from Madras. As early as 1906 two-thirds of the employees in the Jute mills were immigrants and nearly 90% of the labour was imported.

(vii) Humid climate necessary for jute manufacture is also the characteristic of the Hooghly basin.

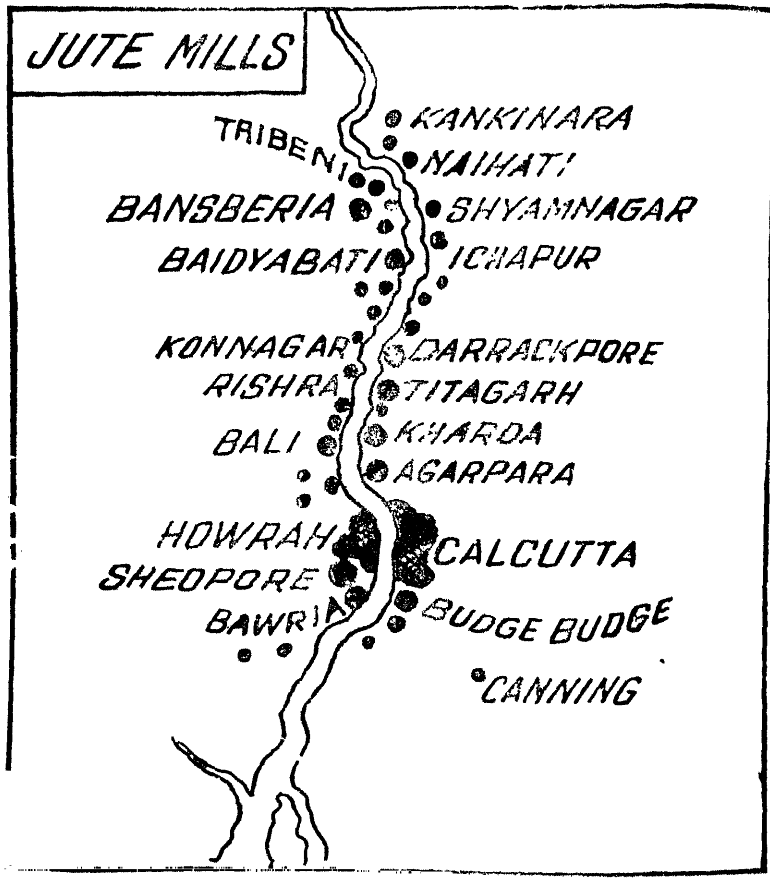


Fig. 62. Location of Jute Mills along Hooghly River

Thus it will be observed that because of the above factors jute industry is highly localized in a small strip of land measuring 96 kilometres in length and 3 kilometres in breadth lying along the bank of river Hooghly, above and below Calcutta—from Tribeni (4.8 kilometres above Calcutta) to Uluberia (32 kilometres below) on the north bank of the river and from Halishahr (42 kms. above) to Birlapur (35 kilometres below Calcutta) on the south bank. This small tract of land accounts for more than 90% of the total manufacturing capacity of the industry. The greatest concentration lies within a 24 kilometres belt

extending from Rishra on the north bank to Naihati in the south. The important centres of the industry are Bally, Agarpara, Rishra, Titagarh, Serampore, Budge-Budge, Sibpur, Salkia, Howrah, Shyamnagar, Bansbaria, Kanvinara, Uluberia, *etc.*

It is interesting to note the absence of jute mills in the principal jute-growing belt of E. Bengal (E. Pakistan). The important reason for it is the peculiar character of the transportational system which entails several transhipment hurdles. The three important districts growing jute are Mymensingh, Dacca and Tippera—all lie on the opposite bank of Brahmaputra river which is unbridged, and the transport across the river involves the problem of transhipment. All raw-jute thus moving to Calcutta on the Dacca section has to be transferred to filats either at Jagannathganj or Narayanganj and loaded on wagons again at Serajganj and Khulna respectively. Had the mills been located in the principal jute-growing belt, the transhipment hurdles had to be undergone twice, once in moving the coal, mill stores, labour, *etc.*, to the mills and then again, the moving of the finished goods to Calcutta for export to consumers' markets overseas and to Indian States.

For some time past there has been a slight dispersion of the jute industry. This may be attributed to increasing demand for goods in U.P., Bihar after the rapid development of the sugar industry, and secondly, to the availability of many local fibres suitable for jute manufacture in Madras, U. P., and Bihar. Hence four jute mills have been established in Madras and Andhra (at Chitwalshah and Naulimarlla) and three in Bihar and Orissa (at Darbhanga and Purnea) and two in U.P. (at Kanpur and Sahjanwan) and one in Madhya Pradesh. It is felt that further despersal of the industry is possible by encouraging the cultivator of Jute in other areas of India.

The geographical distribution of the Jute Mill industry in India is as follows :—

Location of Jute Industry

State	No. of Mills	No. of looms		Total
		H. & S.	Others	
West Bengal	102	65,785	3,788	69,573
Bihar	3	1,005	..	1,005
Andhra	4	1,052	42	1,094
U.P.	3	891	..	891
M.P.	1	220	..	220
Total	113	68,953	3,830	72,783

In 1959, there were 113 jute mills, of which 102 were in Bengal, 3 in U.P., 3 in Bihar; 4 in Andhra and 1 in M.P. The total number of looms were 72,783 of which about 201,050 were for hessian and the rest for sacking.

India has the largest jute manufacturing industry in the world as the following table shows :—

World Distribution of Jute Looms (1956)

Country	Looms (000)	World %
India	68.4	57
Germany	9.6	8
Great Britain	8.5	7.1
France	7.0	5.8
Italy	5.0	4.1
Belgium	3.0	2.5
North America	2.7	2.3
South America	6.0	5.0

Jute Production and Exports

The most important manufactures of jute mills are gunny bags, for packing rice, jute, wheat and oilseeds; hessian cloth or bags used for baling, cotton, wool and other fibres, coarse carpets and rugs, twines cordage and ropes. The following table shows the production of manufacture for recent years:

Jute manufacture (in '000 tons)

Year	Hessian	Sacking	Other	Total
1951-52	309	607	24.8	945.2
1952-53	348	510	33.0	892
1953-54	390	445	30·0	865
1954-55	399	557	38.1	995
1956	415.2	605.5	72.1	1092.8
1957	414.3	548.7	66.9	1029.9
1960-61	408	500	144	1052
1962-63	507	523	169	1199
1963-64	525	488	217	1230

In 1960, 10.85 lakh tons and in 1961, 9.7 lakh tons of jute goods were manufactured in India. In 1962 the production of jute goods was 10.9 lakh tonnes.

The following table shows the production of jute textiles in India since 1950-51.

Year	Production of Jute Textiles (000 tons)
1950-51	837
1955-56	1071
1960-61	1071
1961-62	1001
1962-63	1202
1963-64	1248
1964-65	1292

Among the various problems facing the jute industry in India is its dependence upon raw jute from East Pakis an. The Indian jute industry requires nearly 7 million bales of raw jute per annum if all the mills work to full capacity. But India produced only $1\frac{1}{2}$ million bales of jute in 1947-48; 2 million bales in 1948-49; 3 million bales in 1949-50 and $3\frac{1}{3}$ million bales in 1950-51. In 1954-55 the internal output of raw jute was 2.9 million bales and this along with imports of 1.2 million bales from Pakistan gave an inadequate supply of raw jute to India. Hence, efforts have been made to increase the production of more jute in U.P. Bihar, Madhya Pradesh, Orissa and Kerala.

The production of India's raw jute has now gone up, thanks to the intensive propaganda by the Government and the Indian Jute Mills Association to well over five million bales from less than two million bales in 1947 and the dependence of Indian industry on imports from Pakistan has thus been greatly reduced and the artificial rise in Jute prices, which was the inevitable result of Pakistan's vendetta has now been brought down to a reasonable level and with the removal of the export duties, India's hessian has re-emerged a sa cheapest of the three competing packaging materials in the American market, namely Jute, cotton and paper. As a result, Indian hessian has regained very nearly more than three fourths of the lost American market.

Unlike cotton industry the jute industry of India is essentialy an export industry. It is a dollar-earning industry. The following table gives the figures of jute exports from India :

Year	('000 tons)	Gunny Bags (Value in Lakh Rs.)	('000 tons)	Gunny cloth (Value in Lakh Rs.)
1950-51	345	5,539	26c	5,291
1951-52	473	13,529	287	12,458
1952-53	371	6,139	304	4,024
1953-54	354	4,024	389	6,943
1954-55	451	5,685	360	6,251
1955-56	452	5,419	362	5,908

Our exports of jute manufactures consist mainly of jute cloth, jute bags and twist and yarn. The important buyers of jute bags are U.S.A., Cuba, Australia, China, U.K. and Argentina. Jute cloth is exported to U.K., Canada, U.S.A. and Argentina while there is a considerable demand for twills in Egypt, Levant, South America and South and West Africa.

As the foreign trade or the inland trade of the world increases the demand for jute products for packing also increases. Many countries in the world, therefore, attempt to grow some substitute commodity for jute. In North America, U.S.A., Sweden, S. Africa and Australia Kraft paper bags and cloth have been used for this purpose. But no fibre satisfies the double requirement of cheapness and strength that the jute fibre possesses.

One such substitute is the '*sisal*' grown in East Africa and other parts of the world. It is thought that the quality of the '*sisal*' has been considerably improved recently to make it suitable for producing bags. A feature of the recent growth of industrialism in South America is the attention which the various governments are giving to the use of indigenous fibres for manufacturing purposes. In view of the large variety of fibre plants which are to be found in South America what is happening there is but natural. Brazil and Ecuador are well placed for the expansion of industries concerned with sack and bag making. In Brazil, special attention is being given to the possibilities of '*caroa*'. which is indigenous to the country. Its leaves reach a length of from 1.5 to 2 metres each plant having three or four usable leaves which produce on an average 25 grammes of dry fibre. The distribution of the '*caroa*', plant in Brazil is very extensive. It is abundant in the valley of the River San Francisco and in the sandy portion of Pernambuco, Ceara and Bahia. It is claimed that this Brazilian fibre is better than Indian jute for bag making. The points emphasized in favour of '*caroa*' are that it is naturally white, that there is no necessity for it to be carded and emultioned before being spun and that the longer the spindle the better. It is also claimed that the strength of '*caroa*' is sixty times that of jute.

Newzealand has introduced *Phormium* Tenax, Russia and Argentina use linseed fibre, other natural substitutes are Manila hemp. Bowstring hemp; Kenof; Bimli jute; Bombay hemp; Julital *etc.*

The jute industry of India has profited much from wars in the past. Thus, the Crimean War and the American Civil War brought prosperity and opportunities for expansion, while the two Great Wars created an unprecedented demand in this industry. The trench warfare which prevailed in the wars needed millions of bags. In the second World War also, there was a large demand for sand bags for A.R.P. work. The second World War, however, used fewer bags than the first World War.

Problems of Jute Industry

The main problems facing the Indian jute industry might be stated as follows :

1. To secure its raw jute supplies by increased production of jute within the Indian Union, with self-sufficiency as the goal, in addition, to improve the quality of the jute grown in India so as to bring it up to the general standard obtainable in the jute growing areas of Pakistan;

2. To rationalise the industry's production techniques by installing up-to-date plant and machinery, by taking advantage of the latest developments in jute technology, and by concentrating the manufacturing potential in the more efficient, modernised units;

3. With the aid of the measures referred to under (1) and (2), to reduce costs and stabilise prices at levels attractive to overseas consumers;

4. In conjunction with the foregoing, to pursue an energetic export promotion programme with a view to capturing lost markets and maintaining and expanding existing markets; and

5. To diversify the pattern of the industry's production and to seek uses for jute.

Owing to the shortage and fall in the production of raw jute and tremendous fluctuations in prices, the industry has been in an uncomfortable state for the last several years. It was only in 1961-62 that relief to the industry was felt when raw material became plentiful and level of demand became high and prices were stable. The 1962-63 season was also expected to be good.

In order to encourage modernisation, licences for the import of machinery have been liberally granted to the jute mills in the country and loans are also being offered through the National Industrial Development Corporation (NIDC) for modernisation of equipments.

Despite the very great handicaps imposed by various factors already mentioned, the Indian jute industry has made remarkable progress in the pursuit of these five major objectives and has thus once again demonstrated its fundamental solidarity, its resilience, its flexibility, and its very high organisational abilities.

The Union Government have decided to fix the Fourth Plan target at ten million bales (eight million bales for jute and two million bales for mesta) against the Third Plan's 7.5 million bales (6.2 million bales for jute and 1.3 million for mesta).

WOOLLEN INDUSTRIES

The beginning of the Indian Woollen industry on an organised large scale, goes back to 1876 when woollen mills were installed at Kanpur and Dhariwal. Major expansions in woollen manufacture took

place in 1919-20 and 1948-50. The per capita consumption of woollen goods is, however, still low in comparison with other countries due to the low standard of living of the people and the absence of severe cold in many parts of the country. There is considerable scope for the expansion of the industry by utilizing indigenous wool, the greater part of which is being exported at present, provided there is an increase in the purchasing power of the people.

The Woollen Industry in India is not an important one. The hot climate of the country over the greater part stands in the way of a large demand for woollen goods. The home supply of raw wool is also very inadequate.

Producing Centres

There were 60 large scale and 75 small scale units in India in 1959 which were busy with the production of woollen goods. Out of them 106 were in Punjab, 14 in old Bombay State (now Maharashtra and Gujarat), 5 in U.P., 4 in West Bengal, 3 in Mysore, and 1 each in Delhi. Kashmir, and M.P. The total labour employed in the industry in 1959 was about 18,712.

The region-wise distribution of these units during 1959-60 was as follows :

TABLE CXXXXVII : *Distribution of Woollen Industries in India*

State	No. of units	Woollen and Shoddy Spindles	Worsted Spindles	Looms
Maharashtra	12	15,731	59890	616
Gujarat	2	..	..	..
Delhi	1	..	..	..
Mysore	3	10,478	864	225
Punjab	106	23,765	53974	1562
U.P.	5	14,725	9672	281
West Bengal	4	1,732	6076	141
Kashmir	1	1,542	1500	44
Madhya Pradesh	1	876	..	20
Total	135	68,849	131,979	2889

These mills in India work mostly imported raw material and cater for the needs of the towns mainly. Kanpur, Dhariwal, Ahmedabad, Ludhiana, Bombay, and Bangalore are the important centres of this industry. Kanpur has the distinction of having the largest woollen mill (Lal-imli) in Asia. Indian wool is roughly classified as : (i) Hill

wools used in the manufacture of blankets, tweeds, over-coatings and lower quality of woollen shawls; (ii) *Plain wools* both of coarse and fine type; coarse-type is used for low grade blankets and rug and fine type for better class of blankets, woollen broad cloths, tweeds and good grade carpets. The Indian consumption of raw wool is about 24 million lbs. a year.

Production. Woollen production is divided into two sections, namely, woollen and worsted based on raw materials and the manufacturing process employed. In the worsted section of the industry supperior types of wool and other fibres are put through a series of processes of which the main intermediate products are tops and yarn whereas in the woollen section a wide range of materials, chiefly raw wool, as also, fibres from rags are spun into yarn without the manufacture of any products to tops. Worsted yarn is woven into finer woollen fabrics such as serges, tropical suitings, shawls and knitted goods while woollen yarn is used for the manufacture of blankets, meltons, blaser cloth. The production figures was as follows :—

Year	Woollen/worsted fabrics (Million yds.)	Woollen/worsted yarn (Million lbs.)
1958	40.40	29.10
1959	44.83	28.60
1960	14.61	27.80
1961	13.20*	14.76*
1962	18.29*	18·01*
1963	20.40	22.73
1964	11.74	20.91

Woollen handloom industry is widely established throughout the country. 75% of the industry is concentrated in the colder parts of Indian, *viz.*, U.P., Punjab, Rajasthan and Kashmir. This section of industry produces a wide range of products—blankets, durries, carpets, tweeds, shawls, lohis, coatings, pattees, scarfs, *etc.* There is also some production on a lesser scale of knitted goods, *e.g.*, socks, jerseys and pullovers. Certain goods have a considerable market in the country as well as abroad—such as Kashmir shawls, carpets and namdas; carpets from Mirzapur and Amritsar and druggets from Mysore and Bellary. The mill production of woollen goods in recent years is given below :—

*Million Metres *Million Kgs.

Woollen Manufactures

Year	Woollen and Worsted Yarn (lakh Kg.)	Woollen and Worsted Fabrics (lakh metres)
1950-51	87	..
1955-56	98	134
1960-61	130	133
1961-62	158	145
1962-63	196	189
1963-64	227	197
1964-65	203	112

Export

Indian manufactured wool in the form of carpets, rugs, piece-goods and shawls are exported to U.S.A., U.K., Canada and Australia. In 1958-59, woollen and worsted piecegoods worth more than Rs. 54 lakhs were exported. Woollen hosiery worth about Rs. 1 crore is estimated to be exported every year to the west Asian countries mostly through post parcels.

QUESTIONS

1. Dicuss the factors that have influenced the distribution of the Cotton Textile or Glass industry in India. A.U. 1964.

2. Discuss the localization of, and modern trends in, the cotton textiles industry in India.

CHAPTER 28

Food Industries

The food industry is one of the oldest Indian industries but has made considerable progress in the last few decades.

Food industries include (1) Sugar industry (2) Tea industry (3) Coffee Industry (4) Vanaspati Industry *etc.*

SUGAR INDUSTRY

Sugarcane and sugarcane products have been known in India from very ancient times. It is probable that sugarcane was one of the plants carried on the voyages and migrations of the Australian and Polynesian races between the various countries and islands of the Indian and Pacific oceans in periods long before recorded history. Sugarcane was associated with man in some of the most primitive stages of his agricultural progress, and the early history of sugarcane as a cultivated plant is, therefore, bound up with the advancement, spread and activities of these ancient peoples. The history of India is dotted with many references to sugarcane, but even in the very first available record of its occurrence, we find sugarcane incorporated in agricultural practices of a fairly high order of advancement.

India is the third largest producer of cane sugar in the world, as would be clear from the following table :—

World Production of Cane Sugar in 1958
(*in* '000 *metric tons*)

Cuba	5961	Australia	1438
Brazil	3590	S. Africa	1030
India	2450	Mexico	1368

The country had 2544 thousand hectares under cultivation in 1964-65. The yield per acre in India is 14 to 15 tons, and compares and unfavourably with the yields of 62 tons in Hawaii and 56 tons in Indonesia. It is India's second largest industry next only to textiles.

In 1959 the industry gave employment to 140,000 skilled and unskilled laboureas' and 3,600 university educated men.

In 1959 the total value of sugar amounted to Rs. 190 crores.

Factors of Localization of Industry

Sugar industry for its existence depends upon agriculture for its raw material—the sugarcane, which is greatly a 'weight-losing material' as the sugar produced from it ranges from 9 to 12% of the total weight of the cane used. The cane is more difficult to transport than sugar and its sucrose contents begin to deteriorate after it has been cut from the field and better recovery is dependent upon its being crushed within 24 hours of its separation from the root. In Weberian terminology the sugar industry has a 'material index' of greater than unity, and hence, the industry is not capable of considerable dispersion. Besides, the price of sugarcane constitutes 52.58% of the total cost of white sugar. The factor makes the sugar manufacture a 'raw material-localized' industry and as the local distribution of sugar-cane is more or less entirely dependent on climate and rainfall. Nature plays a decisive role in the location of this industry.

At present the sugar industry is pre-dominantly localized in the two states of U.P. and Bihar, which together account for over 70% of the productive capacity in the industry and employ a little less than three-fourths of the total number of workers employed in the industry. These two states had the advantage of an early start. The earliest attempts to start sugar mills in north Bihar was made by the Dutch planters in 1841-42 and by the English planters in 1899. In spite of the failure of these early attempts the sugar industry came to be established on a sound footing in this region as early as 1903. So that by 1931-32, out of 31 sugar factories in the whole of India 14 were in U.P. and 12 in Bihar. This number increased to 67 in U.P., and 29 in Bihar in 1950-51; and to 68 in U.P. and 28 in Bihar in 1956-57, and to 70 in U.P. and 28 in Bihar in 1959. Out of a total of 163 factories Maharashtra and Gujarat had 27, Andhra 11, Madras 5, Punjab 6, M.P. 5, Rajasthan 2 and Kerala, Orissa, W. Bengal and Assam 1 each. The excessive concentration of the sugar industry in these two States of U.P. and Bihar can be attributed to the following factors :—

(1) More than 90% of the sugarcane acreage lies in Northern India in the Gangetic plain which possesses rich and fertile alluvial soil brought down by the mighty rivers like Jamuna and Ganga. This soil contains adequate quantities of lime and potash so very necessary for the cultivation of cane. Besides the loamy soils found in some regions are exceptionally suited for cane cultivation.

(2) The plain has a level surface, and this factor enables the region to enjoy the facilities of irrigation of the crop. The concentration of sugarcane crop in compact blocks also enables the sugar factories to get fresh cane-supplies direct from the fields.

(3) In case of most of the factory industries, the source of power is an important consideration, and therefore, in establishing such factories the question of the supply of fuel or electricity always plays an

important part in the choice of their location. But the sugar industry is entirely independent of the supplies of coal or electricity for running the machinery, because the bagasse obtained as a by-product is more than enough to meet the entire requirements of the mills for raising the steam to drive the machinery and no supply of fuel from outside is needed.

(4) Being nearer to the consuming markets, these states enjoy the advantages of cheap transport of sugar to these consuming centres.

(5) The States of U.P. and Bihar are thickly populated and hence large amount of labour supply—though inficient—is available cheaply.

(6) Water for factory purposes is abundantly available from numerous canals and rivers flowing in these regions as well as tube-wells.

Producing Centres

A fortuitous combination of all the above advantages is thus responsible for the localization of sugar industry in U.P. and Bihar. The most important centres of productivity are Kanpur, Meerut, Pilibhit, Lucknow, Gorakhpur, Allahabad, the districts of Meerut, Gorakhpur and Rohilkhand division; and—Bhagalpur, Saran, Champaran, Muzaffarpur in the districts of Saran and Champaran in Bihar.

The following table shows the distribution of sugar factories in Uttar Pradesh.

Districts	Situation of Factory
Gorakhpur	Sardarnagar, Pipraich, Dhudhali, Siswabazar, Anandnagar, Ramchandri.
Deoria	Marwi, Bhatni, Batalpur, Gauribazar, Deoria, Captainganj, Chittoni, Laxmigunj, Ramkola, Patrona, Shorahi *etc.*
Basti	Sundarwa, Basti, Burhani, Khalilabad.
Gonda	Babhnan, Nababgunj, Balrampur, Tulsipur.
Bara Banki	Barhawal, Barabanki.
Jaunpur	Shahgunj.
Sitapur	Biswa, Hargaon, Maholi.
Hardoi	Hardoi.
Bijnor	Bijnor, Dhampur, Shohara.
Saharanpur	Deowband, Luxsar, Saharanpur.
Muzaffarnagar	Masurpur, Khatoli, Rohanakala, Samli.
Ballia	Rasda.
Meerut	Meerut, Sakoti, Tanda, Darala, Sivawali, Modinagar.

Nainital	Kicha, Bajpur, Kashipur.
Moradabad	Moradabad, Amroha.
Faizabad	Motinagar.
Etah	Nawli
Pilibhit	Pilibhit
Bareilly	Bareilly, Bohadi
Dehra Dun	Doiwala

In Bihar State the industry is mostly concentrated in Champaran, Saran, Muzaffarpur, Darbhanga *etc*. The following table shows the most important centres of productivity in Bihar.

District	Situation of Mill
Darbhanga	Sakari, Lohar, Tarsaray, Hashanpur Road.
Muzaffarpur	Motipur, Ridha.
Champaran	Badhach Kiya, Motihari, Sugoli, Majholia, Chaptiya, Loriya, Narkatiyagunj, Harinagar, Narainpur.
Gaya	Guraru, Bastigunj.
Sahagunj	Bikramgunj, Dalmianagar, Buxar, Sitalpur, Marhora, Gopalgunj, Hathwa.
Patna	Bihata.

For some time past, the tendency of the dispersal of the sugar industry is noticeable in newer areas especially in Madras, Maharashtra, Bengal and Andhra. Many of these states enjoy exceptional natural advantages for the cultivation of sugarcane. The first two states, being entirely tropical, are climatically best suited for superior varieties of cane. The thick canes of southern India are rich in sucrose content; less than 10 maunds of sugarcane is enough to produce a maund of sugar. The average yield of cane and sugar per acre in Maharashtra is 40 and 3 tons respectively. In exceptional cases in Bombay Deccan an yield of 100 tons of cane and 11 tons of sugar per acre has been obtained. In the sub-tropical north nearly 11 to 13 mds. of cane is required to give 1 md. of sugar. The average yield of cane varies from 12 to 18 tons per acre and the output of sugar per acre is estimated between 0.7 and 1.5 tons.

Besides the crushing season of sugarcane in Maharashtra and Madras is of much longer duration than that of U.P. and Bihar. According to the report of the Tariff Board (1938) the average of the actual number of working days of the central sugar factories for three years for the tropical region was 132 days as against 128 days for the sub-tropical

region.[1] The following table showing the monthly average cane crushings based on the quantities of cane crushed in the typical factories, gives a fair idea of the crushing season in different parts of the country.[2]

% of the Cane crushed in different Months

Months	Sub-tropical Region					Tropical Regions		
	Punjab & Hariyana	Western U.P.	Eastern U.P.	Bihar	Bengal	Maharashtra and Gujarat	Madras	Mysore
October	..	..	..	..	..	6.8	..	9.6
November	13.5	10.7	2.2	2.8	1.6	12.8	1.4	11.7
December	26.5	22.1	19.7	19.4	23.5	15.9	3.2	6.2
January	28.1	22.7	28.2	22.2	26.2	15.4	17.1	5.5
February	18.7	19.5	20.1	21.0	21.6	14.6	22.4	11.2
March	13.2	19.9	19.7	20.9	16.8	15.1	24.0	12.0
April	..	7.8	9.5	8.2	8.7	12.3	18.8	10.7
May	..	1.3	0.6	5.5	1.6	6.8	12.8	9.8
June to Sept.	..	..	..	..	..	0.3	0.3	23.3
Total	100	100	100	100	100	100	100	100

Coupled with the advantages of tropical climate best suited for the cultivation of super varieties of cane, the availability of irrigation facilities, the proximity of consumers' markets and excellent transport facilities, which the ports of Bombay and Madras command in relation to export markets, have placed these states in a very advantageous position for the further expansion of the industry. But despite these natural advantages the industry has not made rapid progress here because : (1) In Madras, the progress of cane cultivation has been hindered by the availability of wide range of alternative cash crops—groundnuts, cotton, plantains, chillies and tobacco in addition to staple food crop—paddy—which is more paying.[3] (2) Futher the over-all cost of sugar manufacture is also very muh higher in Bombay and Madras than U.P. or Bihar. In Maharashtra the cost of cane cultivation is much higher because of the cost of irrigation and the practice of heavy manuring.[4] (3) Moreover, in these states, the sugarcane is not grown in such concentrated and compact blocks as in U.P. or Bihar. The mills, therefore, experience difficulty in getting their supplies of cane from within the reasonable distance.

1 Report of the Indian Traiff Board on sugar (1938), p. 61.
2 Report of the Marketing of Sugar in India (1943), p. 93.
3 *The Location of industry in India*, p. 42.
4 *Report of the Tariff Board on SugarIndustry* (1938), p. 26-27.

The distribution of sugar factories in Maharashtra and Gujarat are shown below :

Ahmadnagar	Manmad
Kolhapur	Kolhapur
Nasik	Rawagaon
Poona	Dhondh
Sangoli	Miraj (Kitur) Urg Khard.
Gujarat	—
Ahmedabad	Hargaon and Tilaknagar, Balwadi, Sakarwadi, Laxami Wadi, Changdevnagar.
Bhavnagar	Dhola.

In West Bengal, the industry is now making progress. Although, some districts possess ideal conditions of cane cultivation, yet the severe competition from alternative crops like rice and jute has prevented the expansion of sugar industry. Mysore and Madras have also developed the sugar industry. The sugar industry in these states has received great impetus from the completion of irrigation projects like the Erwin Canal in Mysore, the Nizamsagar and Tungbhadra projects in Andhra and Cauvery Mettur, and Periyar irrigation projects in Madras.

From the above analysis will be seen that the sugar industry is mainly concentrated in U.P. and Bihar. The sugar interests in U.P. and Bihar have felt that the industry in these two states—which have been the home of the industry since 4th century B.C.—is placed in its most natural surroundings and as such, like jute in West Bengal, sugar has become identified with U.P. and Bihar and so it will be unfair demand that sugar industry should be, more or less, limited to these two states. But it may be pointed out that an over-concentration of the sugar industry in U.P. and Bihar would necessarily mean heavy transportation charges over long distances and consequently considerable additions to the selling price of sugar. A dispersal of the industry in various regions, suitable for its growth and development would be, therefore, advantageous to both the consumers and the producers—since it is likely to reduce the selling price and to increase the demand for sugar. As Dr. R. Balkrishna has rightly suggested, "The future location of sugar factories must be such that they would be expected to cater to a market which is confined to a reasonable radius of distribution provided that no sugar factories are started in the areas where the costs of production are likely to be higher than the price at which the sugar produced in other regions can be sold there."

The following table shows the statewise distribution of the industry in 1958-59 :—

States	No. of factories working	No. of actual working days*	Sugar cane crushed ('000 tons)	Sugar produced ('000 tons)	Percentage of recovery of sugar
U.P.	70	147	9252	888	9.6
Bihar	28	134	3175	311	9.7
Maharashtra & Gujarat	27	141	2678	320	11.9
Andhra	11	160	1279	120	9.3
Madras	5	164	85c	70	8.1
Punjab & Hariyana	6	164	807	69	8.5
Assam	1		23	2	8.6
M. P.	5	123	223	21	94
Mysore	6	229	817	85	10.4
Rajasthan	2	128	77	7	9.0
Kerala	1	136	133	11	8.2
Orissa	1	153	30	3	10.0
W. Bengal	1	140	70	7	10.0
Total	164	145	19420	1914	9.8

*1955-56

A survey of the sugar industry in India, in the light of the protection granted, is interesting. We shall survey both the manufacturing and agricultural aspects over a number of years. In 1917-18 the area under cane in India was approximately three million acres. It fluctuated round this figure during the next fifteen years. It was not until 1933-34 that there was a noticeable increase in acreage, coinciding with the policy of protection introduced. Within the next four years the acreage figure exceeded four millions, and continued in the neighbourhood of this figure until the War. Over three million acres of this are under improved quality cane yielding as much as $15\frac{1}{3}$ tons, in comparison to about $12\frac{1}{2}$ tons per acre in 1930-31. It is clear that from the agricultural point of view the policy of protection given to the Indian Sugar Industry has done considerable good to the country. The cost of production of sugar in India, however, is high when compared with Java or other tropical areas where the cane yield is higher. The most outstanding feature of the sugar industry in India is the **short** crushing season due to the hot, dry summers over the cane area. The cane

must be removed from the fields and crushed before this dry and hot season starts. The crushing starts in December and ends in February. In 1955 the factories worked for 145 days only.

The effect of protection to sugar industry was marked in the number of new mills. The very first year of protection witnessed a doubling of the number of factories operating in the country.

This unprecedented increase, however, created certain difficulties for the industry. Over-production and uneconomic internal competition became marked. In 1934, therefore, an Excise Duty was imposed which slowed down the erection of new factories in favour of the extension of plant in existing factories. The sugar production in India

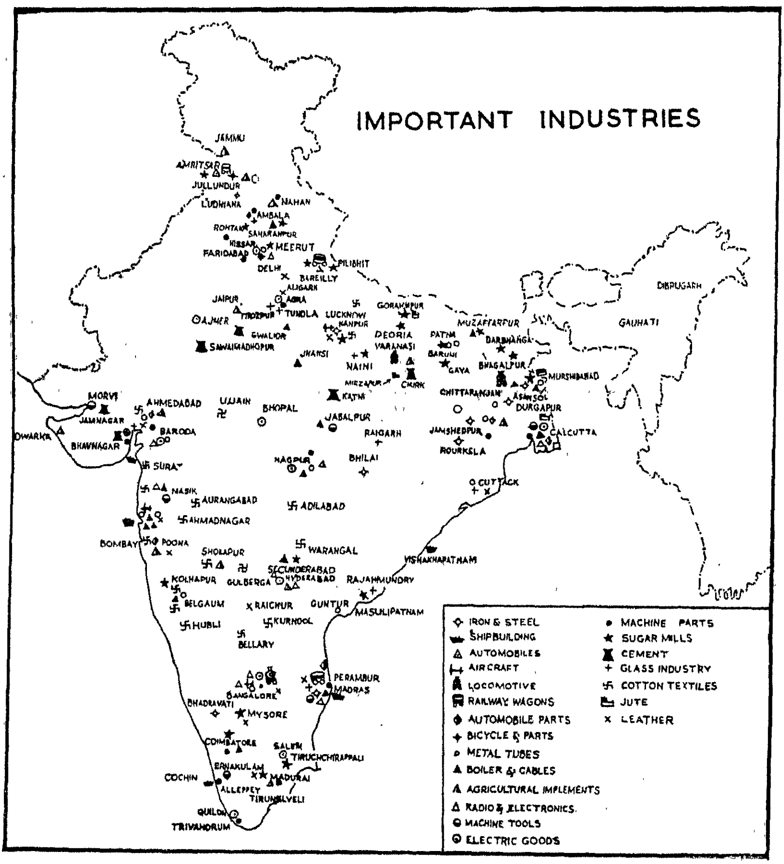


Fig. 63. Important Industries

increased at such a rate that in 1937-38 the net imports of sugar had fallen away to the comparatively insignificant figure of 22,000 tons—essentially of special qualities of sugar not manufactured by Indian factories—against a total consumption of approximately 12,000,000 tons. The sale price of sugar also came down from about Rs. 9 6 per maund to about Rs. 6 9 per maund. The conditions, however, have changed now. In 1953 the Government changed its policy and imported foreign sugar.

On account of the peculiarity of the climate in Northern India, which limits the supply of cane to the factories only to a few months, from about December to March, the sugar factories have to remain idle for the greater part of the year. Even during this short crushing season, some factories are unable to get enough cane. There is a tendency on the part of the factories, therefore, to acquire land near their sites cultivating sugarcane on modern lines. This is an effort to copy Java and Cuba, *etc.* In India the sugar factories have to depend upon the cultivator for the supply of cane.

In Southern India crushing period is a longer one, as the hot, dry and scorching summer of the Indo-Gangetic plains is not felt there.

Most of the cane juice is water and is evaporated or drained off as molasses when sugar crystals are made from it. The total amount of sugar obtained from the cane is only about one-tenth of the weight of the cane. In Java and other tropical islands this is slightly more than in India, owing largely to the efficiency of the sugar mills. In India, only 1.39 tons of sugar is recovered per acre, as against 6.48 in Hawaii; 5.07 in Peru: 6.44 in Indonesia, 3.65 in Philippines and 2.43 in S. Africa.

Production

The industry is mostly concentrated in North India, Uttar Pradesh and Bihar between themselves contributing as stated above more than 75 per cent to the country's production. The state wise figure shows that U.P. produced 57 per cent, Bihar 14.1 per cent, Maharashtra and Gujarat 11 per cent, Andhra 4.1 percent and Madras 3.2 percent. The rest of the states accounted for the balance 10.6 per cent. The following table shows the production of Sugar in India.

TABLE CXXXXVIII : *Production of Sugar in India*

Year	Production (in lakh tons)
1951-52	14.94
1952-53	12.91
1953-54	10.88
1954-55	15.94
1955-56	18.56

1956-57	20.00
1957-58	20.36
1958-59	19.12
1959-60	24.44
1960-61	30.3
1961-62	27.1
1962-63	21.5
1963-64	25.7
1964-65	32.6

It has been estimated that approximately 55% of the total cane produced in India is utilized for the purpose of making *gur* and *khandsari*. Only 25 p.c. goes to the mills for the manufacture of crystal sugar. In India three types of sugar are made—Gur or jaggery, khandsari and white sugar. (i) Of these the simplest is jaggery, being merely cane juice boiled and solidified. Juice is boiled in open pans to solidify. (ii) Khandsari is made through an indigenous process by the molasses being separated from sucrose. (iii) White sugar is directly produced in the factories in India.

In 1958-59 in India there were 164 working factories and 120 average working days. Total amount of sugar cane crushed was 19,420,000 tons and sugar produced 1,914,000 tons. In 1960-61 there were 175 sugar mills in India and the production of sugar was 30.29 lakh tonnes. In 1961-62 the output was lower at 27.14 lakh tonnes which was largely on account of poor crop. The 1964-65 production at 32.58 lakh tons was the highest on record so far.

The consumption of sugar in India is lowest in the world. We consume only 46.1 kg. of sugar per head (1957) as against 54.8 kg. in Australia and 51 kg., per year per head in Cuba; 44.4 in New Zealand; 42.0 kg., in Canada; 29.1 kg. in France; 51.5 kg. in U.P. and 54.1 kg. in Denmark. In 1962, however, internal consumption showed an upward trend. Consumption is shown in the following table.

Consumption of Sugar in India

1951-52	11.7	lakh metric ton.
1952-53	16.6	,,
1953-54	18.1	,,
1954-55	17.2	,,
1955-56	19.0	,,

Exports

In past, India depended on foreign countries for sugar and in 1929-30, we imported nearly 9½ lakh tons of sugar, but in recent years, as the sugar output has increased, imports are only nominal. However, restricted exports of sugar to the extent of a few thousand tons per annum has been taking place to some of the neighbouring countries. The chief difficulty in increasing exports is the high cost of Indian sugar. As against the ex-factory price of Rs. 27 per md. of sugar in India, the landed cost of sugar in most of the countries is Rs. 21 to 23 per md. The cost of sugar production is high in India because most of the factories are below the optimum size of 800 tons of cane-crushing capacity per day.

In 1957-58 we exported over 150,000 tons of sugar. In 1962 the exports increased, amounting to 3.73 lakh tonnes.

The following table shows the exports in terms of rupees since 1957.

1957	12.88	lakh Rupees
1958	3.67	,,
1959	2.54	,,
1960	1.60	,,
1961	15.54	,,

By-products of sugar industry

The three main by-products of sugar industry are bagasse, pressmud and molasses. These are used as raw materials by a number of industries. Bagasse is widely employed in the manufacture of paper pulp and card-board. Wax is extracted from press-mud and molasses is used in the manufacture of aconitic acid, industrial and power alcohol, chemicals, tobacco, curing either chloroform, acetic acid, *etc.*

The industry provides valuable by-products which can serve as raw materials for other industries, such as power alcohol, paper, paper-board, and straw boards. The development of these and other subsidiary industries have a cumulative effect on the extent of employment provided by the sugar industry.

POWER ALCOHOL

There are 44 distilleries in India which distil alcohol cane Molasses. Alcohol is available in three varieties. It can be used as drink : secondly, it can be used for manufacture of a number of chemicals, and thirdly, it can be used as a motor fuel, for the production of mechanical power known as power alcohol. There are at present 19 units equipped with necessary facilities for the production of power alcohol—with an average rated capacity of 12.839 million gallons of power alcohol and

3.948 million gallons of commercial alcohol. Of these units 12 are in U.P., 2 in Bihar, 1 in Andhra, 1 in Mysore, 1 in Bombay and 1 in the Punjab.

The following table shows the distribution of alcohol factories in India.

State	No. of Factories	Production Capacity lakh lit.	Important centres
Bihar	[illegible]	99	Narkatiyagunj, Marhowrah.
U. P.	20	985	Rajaka Shahaspur, Bahari, Samli, Bareilly, Deoria, Modinagar, Captaingunj, Darola, Shahgunj, Sardargunj, Meerut, Nababgunj, Rampur, Hargaon, Gola, Mansurpur, Pi'khani.
Maharashtra	6	191	Sakarwadi, Tilaknagar, Bal handnagar, Kolhapur, Chichali, Sangli Nira.
Madras	1	32	Tiruchinapalli.
Andhra Pra-desh	6	191	Sakarnagar, Bobili, Tanuku.
Punjab	3	81	Jamuna Nagar.
Mysore	2	77	Mandya, Dagar Khurd.
Rajasthan	2	23	Udaipur, Jaipur.
Kerala	3	27	Chalakundi, Saratlai.
Madhya Pradesh	2	18	Ratlam.
West Bengal	3	72	Calcutta.
Total	55	1805	

The molasses can also be used as cattle fodder; for building road surfaces mixed with asphalt or bitumen and as manure.

U.P. is the largest producer of molasses in the country as is evident from the following figures :—

(*Production in* 000 *tons*) 1955-56

U.P.	3,813	West Bengal	43
Bihar	1,228	Orissa	27
Maharashtra and Gujarat	683	Mysore	187
Andhra	643	Madhya Pradesh	150
Madras	270	Kerala	36
Punjab	168	Rajasthan	59

The following table gives the productions of alcohol :—

Years	Power	Rectified spirit	Denatured Spirit
	(In '000 gallons)		
1950	4,497.6	3,435.6	1,477.2
1951	5,809.2	5,019.6	1,966.8
1952	7,742.4	4,668.0	2,178.0
1953	8,120.4	4,376.4	2,493.6
1954	8,007.6	4,630.8	2,835.6
1955	10,432.8	5,156.4	2,889.2
1956	10,143.2	3,999.6	3,392.8
1957	10,136.4	5,064.0	3,439.2
1958	8,509.2	5,951.2	3,829.2
1959	80736.4	7770.0	541.64
1960	49327	41177	29392
1961	53668	50491	40357
1962	52210	61614	49206

In 1960-61 the production of power and industrial alcohol was 22 million gallons. During the Third Five Year Plan period, the production of power and industrial alcohol was 72 and 60 million gallons respectively.

Trade

Imports of alcohol are banned, but small quantities are imported along with drugs and perfumed spirits or in the form of liquors. Exports of alcohol are confined to despatches of denatured spirit to Burma and Ceylon and small quantities of rum.

In view of the prospects of plentiful supply of molasses in the Fourth Flan Period and considering the almost unlimited number of industrial uses of alcohol, the draft outline of the 4th Plan has accorded a notable role to the development of the alcohol industry.

VANASPATI INDUSTRY

Vanaspati industry was first introduced into India after World War I by imports from Europe. The first Vanaspati factory in India was established in 1930. The Government helped the industry by giving it protection. Vanaspati is mainly made from cotton seed oil and groundnut oil.

In April 1951, there were 48 factories in India with an annual rated capacity of about 330,000 tons. In March 1960, their number had increased to 51 with a rated capacity of about 412,000 tons. The following table shows the distribution of Vanaspati industry in India.

State	No. of Factory	Production Capacity in 000 tons
Andhra Pradesh	3	19.80
Bihar	1	13.50
Delhi	2	42.00
Gujarat	5	33.15
Kerala	2	5.40
Madhya Pradesh	2	11.25
Madras	6	17.19
Maharashtra	9	132.00
Mysore	4	14.40
Punjab	2	12.90
U. P.	5	87.00
West Bengal	8	81.90

Production

The actual production of Vanaspati during 1947 was 1.35 lakh tons. The consumption of Vanaspati has considerably risen since independence.

The actual output of Vanaspati during 1959 amounted to 316,788 tons as against 293,781 tons in 1958, 301,356 tons in 1957 and 255,612 tons in 1956. The following table shows the production of Vanaspati in India.

Year	Production (lakh tons)	Capacity (lakh tons)
1946	1.35	1.92
1947	0.95	2.03
1948	1.30	2.16
1949	1.56	2·84
1950	1·72	3.00
1951	1.72	3.26
1956	1.56	4.12
1957	3.01	4.00
1958	2.95	..
1959	3.16	..

1960	33,765,12 metric tons
1961	3,390,960 „ „
1962	3,694,764 „ „

Export

The Vanaspati actually exported in 1955 was 16,000 tons valued at about 2.05 crore rupees. The export during 1957 was 4,000 tons valued at Rs. 0.85 crores. The countries to which Indian Vanaspati ghee *etc.*, are exported include Britain, Australia and Burma. The following table shows the exports of Vanaspati in India.

TABLE : *Trends of Export (Lakh tons)*

1955-56	163
1956-57	109
1957-58	41
1960-61	854
1961-62	582
1962-63	1317

QUESTIONS

1. Discuss fully the geographical distribution of sugar industry in India.
2. Discuss the production, distribution and economic importance of tea industry in India.
3. Discuss the possibilities of expanding vegetable industry in India.

CHAPTER 29

Other Industries

Significant strides have been made by other industries such as glass and cement industry in India.

GLASS INDUSTRY

Glass is used for mirror, furniture, shelves, door panels, table ware, art glass, bangles, in building construction *etc.* Glass has found wide use in electrical industry, for power insulators, power fuses and current resisters.

Historical Development. In India the art of glass making was known from time immemorial. But glass making on modern lines is of very recent origin. Manufacturing of glass in India on modern lines dates from the nineties of the last century, but most of the pioneering factories were not successful. It was only during the first World War that real progress in this industry was made.

Rapid progress has been made in the glass and glassware industry since post-independence days. Despite a fall in the number of factories from 165 in 1948 to 136 in 1952, the fixed, working and total capital have increased from Rs. 2.44 crores, Rs. 1.23 crores and Rs. 3.99 crores to Rs. 3.77 crores, Rs. 1.59 crores and Rs. 5.36 crores, resulting from the large scale rehabilitation and modernization of some of the units and new factories equipped with upto date automatic and semiautomatic plants. The latest ones, deserving special mention, are the Hindustan-Pilkington Glass Co., Asansol and the Hindusthan National Glass Manufacturing Co., Rishra.

Raw materials. There is a considerable home market and some of the raw materials are easily available. By far the most important raw material is the silic sand.

The raw materials required for the manufacture of glass may be classified as follows—

(1) The basic raw materials required for the production of bulk glass : sands, soda ash and lime.

(2) Special materials for imparting particular characteristics : barium carbonate, felspars, magnesia, zinc oxide, lead oxide, borax *etc.*

(3) Decolorizers, colouring and finishing agents and opacifiers : selemium, manganese dioxide, arsenious oxide, sulphur *etc.*

(4) Oxidising and reducing agents : potassium nitrate, carbon *etc.*

Sands of a degree of purity requisite for glass making are found at several places in India. At Mangai-Hat and Patraghatta, in the Rajmahal hills, there occur white Damudas and stones, which after crushing, washing and sieving, yield sand from which ordinary quality glass can be made. From Lohagra and Bargarh near Allahabad a suitable sand is obtained by crushing and grading a Vindhyan quartzite. Good quality sand can be obtained from sandstone at Sankheda and from the Sabarmati river sand at Pedhamli, both near Baroda. Sands of suitable quality also occur at Jabalpur. The sands found at Bargarh and Lohagra are used by most of the factories. In addition, sands from Jejon Doaba in the Hoshiarpur district and from Sawai Madhopur in Jaipur State are also used by some factories. Suitable sand also occurs in Mysore State.

Among the chemicals used, the Soda ash sulphur and manganese oxide are exclusively imported from U.K. and U.S.A. Refractory materials for the furnaces and coal for firing the furnaces are available in India. A cheap supply of coal is of a great importance. The choice of the raw materials for glass making is a matter of great importance as the quality of the finished product depends very largely on the purity of the material used. Suitable major raw materials are available in India, but the important consideration is the location of the factory, so that these materials may be brought together cheaply. Borax has also to be imported but dolomite, saltpetre and lime stone are found in large quantities in the country.

In addition to the manufacture of glass by modern methods, there is also the indigenous glass industry for making bangles from the inferior varieties of glass. This glass is manufactured from the impure sands of the rivers and the eflorescent alkali salts of the *reh*, commonly found in many parts of India.

Location of Industry

Amongst the factors of localization of the glass industry, supply of raw material, fuel and transport exert considerable influence on the location of the industry. Market and labour play a secondary role in the establishment of the industry. Other factors remain there, as without them the industry could not be established.

There are 131 registered glass factories (excluding 100 bangle units) in India. Out of the total number of factories in 1958 only 84 were actually engaged in production, 25 had been temporarily closed down and 22 more or less permanently. In November 1956 the statewise distribution of factories was as follows :—

State	No. of units
W. Bengal	28
U. P.	24
Madras	9
Bihar	8
Punjab	3
Delhi	3
Rajasthan	2
Gujarat & Maharashtra	18
M. P.	5
Andhra Pradesh	2
Mysore	2
Other states	5
	109

The Indian glass industry may be divided into two categories : (i) the cottage industry making mainly glass bangles in small furnaces from glass blocks produced in factories, (ii) Modern factory industry.

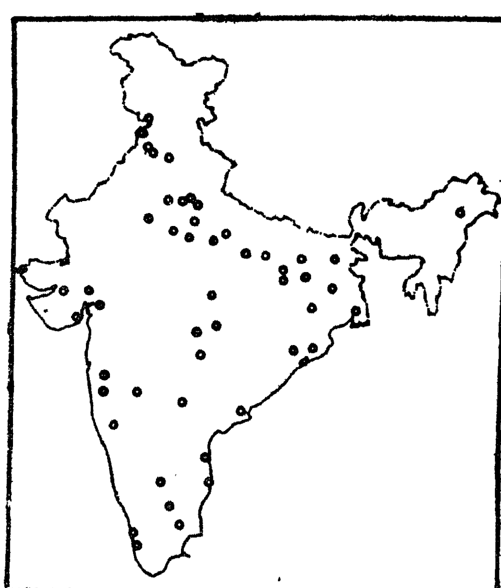


Fig. 64. Location of Glass Industry

(i) Cottage Industry is, though spread over different parts, mainly concentrated in Ferozabad district of U.P. and the Belgaum district of Maharashtra. At Ferozabad bangles of all types are made and these supply nearly one-third of India's demand. This industry is localised here because of the availability of good sand, saltpetre in the neighbouring areas and the skilled artisans—sisgars who have been doing this job for about a century. Coal is obatined from Bihar.

(ii) The factory industry is mostly confined to U.P., Bombay, West Bengal and the Punjab and Bihar.

In U.P. there are about 34 factories which manufacture glass-sheets, pressed and hollow wares. Bahjoi is the important glass-sheet making centre in India. Hollow and pressed wares such as motor-head-lights, reflectors, chimneys, and bulbs, are manufactured at Hathras, Naini, Bahjoi and Shikohabad. The chief factors favouring the location of this industry in U.P. have been the abundance of good-quality sand, potash, nitrate and lime in the state, but coal has to be got from Bihar. The glasswares of U.P. have country-wide market but the industry suffers from two main defects, *viz.*, that the workers are often unorganized and secondly, the designs, *etc.*, are a bit old fashioned.

There are at present 22 glass manufacturing factories in Maharashtra and these factories are located at Telegaon, Bombay, Nagpur, Poona, Satara, Kolhapur and Panchmahal, and generally produce bottles, glassware, thermosflasks, lampware, beakers and sheet glass.

In West Bengal factories at Calcutta, Howrah, Belgachiya, Belur, Sitarampur produce bottles, glass tubes, flasks, test tubes, beakers and flat glass. The main centre of the industry is Calcutta where over 30 factories are located.

In the Punjab factories at Amritsar and Ambala produce hollow wares and scientific and precision goods.

Two factories for the manufacture of sheet glass are being set up, one at Tiruvottiyur and the other at Sembiam in Madras State with an initial investiment of about Rs. 50 lakhs each with Belgian collaboration. For the first time in India, the factory at Sembiam would adopt the "Pittsburg process" for the manufacture of sheet glass, which, according to technologists, produces better quality glass.

The Indian factories usually produce glass cakes for bangles; heads, bottles, phials, tablewares and lampwares; sheet and plate glass; and surgical and laboratory requirements in glass. Recently the manufacture of thermal flask, and glass-tubes have also begun.

Production

The monthly rated capacity and output of sheet glass in million sq. ft. increased from 1.95 and 0.80 in 1950 by stages to 8.4 and 2.76

in 1954. Accumulation of stocks averaging more than a month's output at the factory and keen internal competition during recent months have brought about a reduction in the monthly output to 1.7 mil. sq. ft. in May 1955.

In regard to laboratory glass high quality ware is being produced in the country but consumer prejudice has stood in the way of the consolidation of the Industry—the monthly rated capacity and output for 1948 at 506 tons and 160 tons having sagged to a record low of 428 tons and 111 tons in May 1955 with an ever-yawning gap of idle capacity.

Glass shells capacity has increased from 13.5 lakh pieces in 1948 to 22.8 lakh pieces per month in May 1955.

A similar rising trend has been noticed in the monthly rated capacity and output of miscellaneous glassware, though every increase in the former—unattaended by a corresponding rise in the latter—has expanded the idle capacity further and further. The respective figures were, 11,922 tons and 5203 tons in 1948 and 18910 tons and 6004 tons in May, 1955.

The following table shows the production of glass industry in India.

TABLE CXXXXIX : *Production of Glass and Glasswares in India*

Year	Sheet glass (000 Sq. ft.)	Laboratory Glassware (tons)	Glass Shells (lakh pieces)	Other Glass-ware (tons)
1952	9,043.2	1,476	166.8	85,368
1953	22,786.8	1,320	169.2	72,444
1954	33,112.8	1,512	224.4	85,188
1955	38,883.4	2,496	260.4	100,008
1956	47629.2	3,360	327.6	123,532
1957	54226.8	3,156	391.2	123;528
1958	74858.8	3,672	402.4	146,796
1959	80565.2	5,280	387.6	157,308
1960	81208.4	4872	445.2	170,790
1961	72976.8	3804	622.8	177,384
1962	8556.0	4404	656.4	186,336

During the Third Plan, the annual capacity and production of glass and glasswares was to be increased from3.7 and 2.25 lakh tons in 1960-61 respectively to 6.15 and 4.4 lakh tons in 1965-66 respectively.

Glass products in India include bangles, bottles, table-ware, lamp-ware, scientific glassware, shells for electric lamps, thermos flasks and miscellaneous glasswares.

The new items produced since 1960 are coloured sheet glass, safety glass for automobiles, aeroplanes, *etc.*, glass wool and fibre, glass syringes synthetic stores and glass chatons, *etc.*

Trade

Special types of glass aritcles which are not manufactured in India are imported from Czechoslovakia, Germany and Belgium.

Our export trade for glass and glassware has not yet properly developed. We exported glass and glassware to the value of Rs. 28 lakhs during 1955-56 as against the value of exports of Rs. 43.53 lakhs in 1951-52 and 26.67 lakhs in 1953-54. Glass and gassware are now being exported to more than twenty countries in the world. Aden, Ceylon, China, Burma, Malaya, Arabia, Iraq, Afghanistan, Indonesia and Bahrein Island are leading customers.

CEMENT INDUSTRY

Natural cement is made from cement rock, a naturally occurring raw material. That need only to be turned and pulverised long before Portland cement was made in 1824 by Joseph Aspdin, a bricklayer of Leeds, England, cement or something akin to it was known, though in other forms. The Great Pyramid of Cheops, one of the seven wonders of the world, is held together by burnt gypsum with the Egyptian prototype of cement. The aqueducts of Carthage in Africa were built with its aid long before the Christian era.

Historical Development

In India the first attempt to manufacture cement was made early in this century when in 1904 a small factory was opened in Madras. The enterprise failed but ten years later the industry was revived and three factories were established at Porbandar, at Katni and at Lakheri. With World War I, indigenous manufacture was stimulated and by 1918, the three factories produced between them a modest 85,000 tons a year. During the years of the postwar boom, the Indian cement industry expanded. Between 1919 and 1924, seven more factories came into existence. But so rapidly did their production outstrip demand that the industry was faced with the problem of selling its output and the producing units soon found themselves competing with one another. In the ensuing rate-war all suffered. Some companies were forced into liquidation.

In 1925 the Government of India ordered the Tariff Board to inquire into the working of the industry. The Board's findings emphasised the need for cooperation among the manufacturing units and ac-

cordingly the Indian Cement Manufacturers' Association was formed to regulate cement prices. By regulating prices and sales, the industry was placed on a firm footing and by 1934 its foundation was well and truly laid. In that year one more factory went into production, raising the total output to 19,72,000 tons a year. The Indian cement industry was fortunate in attracting the services of men of outstanding initiative and foresight.

Raw materials. The manufacture of cement also is of recent development in India. The increasing home market due to increased activity in building trades and new uses of concrete have led to considerable expansion.

Cement is usually produced by the action of intense heat on a finely powdered mixture of limestone or marl with clay or shale. The mixture should contain about three-fourths of calcium carbonate and about one-fourth of clay material, with a little gypsum.* In India some of the limestones contain all the ingredients in almost correct proportions. At Banmore (Gwalior Portland Cement Co.) the limestone so nearly contains the necessary things that very little clay has to be added. At Lakheri (Bundi Portland Cement Co.) no clay at all is used, the correct proportion being obtained by mixing different grades of limestone. In other cases substantial amounts of clay have to be added. The proportion of gypsum necessary is about 5 per cent.

Abundant supplies of limestone of excellent quality exist in many parts of the country close to the railway, so that the cement factories have usually been established near the quarries. Suitable caly is invariably found close to the factory. Gypsum is produced in India but has to be brought from long distances at high cost of transport. Counter-balancing these natural advantages, almost all the cement factories are situated at such a distance from the coal-fields, that the freight on coal is very high. Inferior local coal may in some cases be used for damage to the machinery is small, but the coal used in the kiln must contain low percentage of ash. At least half of the coal used in the factories, therefore, must be from the Bengal and Bihar coal-fields.

With the exception of the works in Saurashtra and Madras, none of them are within short distances of the seaports. This gives them

*Portland cement of standard specification contains

	60—70	per cent.	$Ca\theta$
	20—25	,,	$Si\theta_2$
	2—12	,,	$Al_2\theta_3$ & Fe_2 O
And a maximum of	5	,,	Mgo.

Usually three parts of limestone and one part of clay are mixed together. In ordinary practice to get one barrel of Portland cement (375 lbs.) the raw materials used amount to about 610 lbs. of which roughly 460 lbs. would be limestone and 150 lbs clay. Limestone with high magnesia (Mgo) is useless for cement.

an advantage so far as the inland markets are concerned, as they are in a better position to compete against imported cement. In the ports themselves, however, which being the largest towns, are great markets for cement. The Indian cement had to face severe competition in the beginning. An import duty is, therefore, levied on imported cement.

More than four-fifths of the home demand is supplied by Indian factories whose output is increasing every year. The imports are declining every year. From 125,988 tons in 1928-29 they came down gradually to 55,936 tons in 1935-36. The Indian production in 1935-36 was about 9 lakh tons. In 1942 there were, however, 20 cement factories in India with a total capacity of 28 lakh tons. In 1936 Indian production (9.8 lakh tons) was about one-eighth of the total world production. The imports fell from 147,704 tons in 1948-49 to 12,600 tons in 1952-53.

The Indian production rose from 35 lakh tons in 1953 to 49 lakh tons in 1956, 68 lakh tons in 1959, 78 lakh tons in 1960, 82.80 lakh tons in 1961-62 and 88.60 lakh tons in 1962-63.

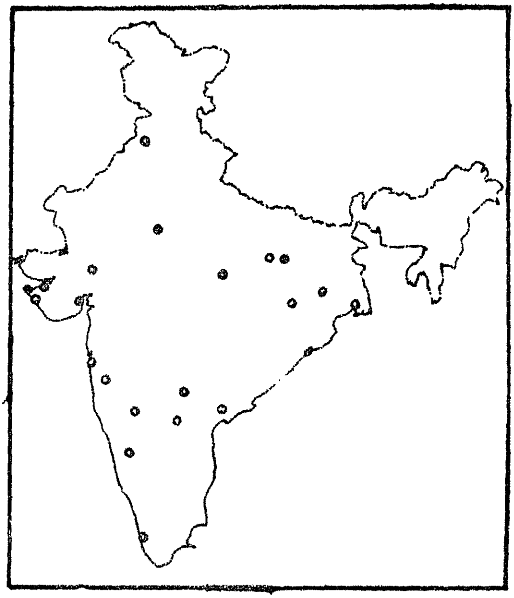


Fig. 65. Location of Cement Industry

Location of Industry. There are now 28 cement factories in India. The cement industry of India employed about 30,000 persons in 1955. Nearly 40 crores are invested in the industry. The consumption of fuel, electricity, lubricants amount to about 5 crores and that of raw materials

Rs. 10 crores. On account of the construction of the various irrigation projects in the country there has been a great demand for cement. To increase the production further a new cement factory had been constructed in U.P. at Churk about 50 miles from Chunar with which it is connected by rail. Its capacity is about 700 tons per day. Out of the raw materials needed in the manuacture of cement two, namely, limestone and laterite, are obtained locally, while gypsum and coal will be imported from Bikaner and Jharia respectively. Over 1.30 crore tons of limestone sufficient for 40 years is found at the Markundi quarry, 2.8 miles from the factory. Laterite is obtainable from Lussa, 27 miles away.

At the beginning of 1962-63 there were 34 factories of which 2 are owned by the U.P. and Mysore Governments. Of the factories, all privately owned, 7 are in Bihar; 4 in Gujarat and Maharashtra; 3 in Madras; 2 each in Mysore, Andhra, Madhya Pradesh, Rajasthan and the Punjab and one each in Kerala and Orissa.

Dalmianagar, Jalpa, Chaibasa, Sindri, Khalari, Kalyanpur and Sone-valley lead Bihar in cement production. In most years Bihar and Madras produce about 50% of the Indian output. Cement is now manufactured by more than four factories in Madras. Madras is the leading producer outside Deccan in the Indian union. Gujarat is also an important producer in India. Portland cement is manufacured in over 35 factories of India.

Churk is an important producing centre in Mirzapur district of U.P. The Sone valley has the advantages of high grade local limestone and shale, nearby coal, a good labour supply, and is equidistant from Calcutta and Visakhapatnam. The cement manufactured at Churk turned out to be a high quality of Portland, shipping large quantities overseas. The following table shows the important centres of cement industry in India.

State	Important centres	Production capacity
Bihar	Dalmianagar, Jalpa, Chaibasa, Sindri, Khalari, Kalyanpur and Sone Valley	17 lakh tons
Andhra Pradesh	Hyderabad, Bezwada, Krishna.	9 ,,
Gujarat	Okhamandal, Sevalia, Jamnagar, Ramawap, Dwarka.	11 ,,
Madras	Madhuharai, Mangalagiri, Tirunelveli, Dalmiapuram.	12 ,,
M. P.	Katni, Jabalpur, Gwalior.	9 ,,
Mysore	Bangalore, Bhadravati, Shahbad.	9 ,,
Rajasthan	Sawai Madhopur, Lakheri, Kheri Bundi	12 ,,
Orissa	Rajgangpur.	4 ,,
Punjab	Surajpur, Bhupendra, Dalmiadadri	6 ,,
Kerala	Kottayam	$\frac{1}{5}$,,
U. P.	Churk	2 ,,

At present there are about 11 different companies manufacturing cement of which Associated Cement Co. Ltd., is the single largest manufacturing group. The Dalmia group comes next.

Production

The steady growth of the industry is shown below in lakh tons :—

Year	Production	Capacity
1948-49	17	33
1949-50	22	29
1950-51	27	33
1951-52	32	37
1952-53	35	38
1953-54	40	42
1954-55	44	44
1955-56	46	50
1956-57	56	66
1960-61	78	90
1961-62	83	..
1962-63	89	..
1963-64	94	..
1964-65	105.8	..

The *per capita* consumption of cement in India is the lowest in the world. As against the *per capita* consumption of 516 lbs. in the U.S.A.; 411 lbs. in the U.K.; 460 lbs. in Denmark, 90 lbs. in Japan, 740 lbs. in Sweden and 716 lbs. in Belgium, the *per capita* consumption of cement in India is as low as 27 lbs. But with the large number of development schemes, it has gone up so much so that now the demand has exceeded the supply, which was further enhanced by the material emergency.

During the Third Plan period the production of cement was 132.1 lakh m. tons. This may be compared with the respective figures for 1960-61 given in the preceding table.

Trade

The exports and imports respectively of cement by land and sea during the period 1951 to 56 were as follows :—

Year	Imports	Exports
1951-52	10,312 tons	67,758 tons
1952-53	3,652 ,,	57,441 ,,
1953-54	6,694 ,,	86,116 ,,
1954-55	6,000 ,,	101,429 ,,
1955-56	10,717 ,,	51,351 ,,

Over 1 lakh tonnes of cement was exported during 1961-62. An export target of 1.50 lakh tonnes has been set up for one year beginning July 1962.

Fourth Plan Programme

Schemes to establish 31 new factories have been approved by the Government; in addition to schemes for the expansion of several existing factories. The new units will have a total capacity of 5.6 million tons. Of them 7 will be established in Andhra Pradesh, 7 in Bombay, 3 each in Rajasthan and Madhya Pradesh, 2 each in Assam, West Bengal and Madras, one each in U.P., Bihar, Orissa, Pondicherry and Mysore. The expansion scheme will increase the capacity by about 4.4 million tons. The expansion of the industry will call for an additional investment of Rs. 50 to 60 crores and give employment to 50,000 to 55,000 extra workers.

TOBACCO INDUSTRY

From the dawn of history India has been growing an indigenous variety of tobacco and there were numberless people in this country who have been in the habit of consuming tabacco in some form or the other. Later on it is on record that the Portuguese merchant adventurers who landed round about Surat in the year 1508 brought a special variety of tobacco seeds which they planted in the western coast of India. Today India ranks as the third largest grower of tobacco in the world next to the U.S.A. and China—even though recently the Government went to the mainland of China and other South East Asian countries and were successful in negotiating big trade deals for the export of India's surplus tobacco.

Tobacco is now widely grown in India but the production is mostly confined in West Bengal, Bihar, Madras, Gujarat, Maharashtra and Andhra.

The average yield per acre is 760 lbs. dry weight. Not more than half of the quantity is used for smoking hookah. Next in order of importance comes the type which is principally used in the manufacture of cigarettes and also exported to foreign countries. These are followed by beedi, chewing cheroot and snuff tobacco. Commercially useful tobaccos are only two of the many types and they are nicotian a tabaccum and nicotiana rustica. The first has about 2% of nicotine and the other about 8%. Nicotiana rustica is used for hookah, chewing and snuff purposes. Nicotiana tabaccum is used in the case of cigars, cigarettes, cheroots and beedies. Almost 90% of the tobacco grown is absorbed for domestic consumption.

The industry got its impetus during a period of 15 years—from 1920-35. There has been a general increase of the number of tobacco factories since 1923. During the year 1935, 22 registered cigarette factories employed 8,000 persons daily.

Cigarettes

Before World War I, indigenous manufacture of cigarette was on a very much restricted scale mainly confined to Calcutta and Monghyr in Bihar. The increasing demand and elimination of foreign competition during and after the war years gave an impetus for starting a number of new units of production and the result has been very encouraging. Now the country has got over 25 manufacturing companies and most of the well-known brands of cigarette are now being made in India. The position now is that the indigenous industry now satisfies 99 per cent of the country's requirements.

Over half of the cigarette leaf produced in India is purchased by the Indian Leaf Tobacco Development Company for export and sale to the manufacturers in the country. About $\frac{8}{4}$ of the output of cigarettes in India is handled by 25 Indian factories. These factories are located at Bangalore, Saharanpur, Monghyr and Calcutta.

The installed capacity of the factories is 4000 crores of cigarettes per annum—and the actual production has been consistently on the increase.

Between 22-23 million lbs. of tobacco leaf is used for the manufacture of cigarettes. About 15% of this is imported from the United States. Annual production of cigarettes is 22,828 million its value being nearly 10 crores of rupees. Leaves undergo a complex process of grading, blending, flavouring and moistening before being ready for manufacturing. Fast running machines and skilled workers are required in order to make satisfactory cigarettes. The cigarette paper [1] is properly printed by the same machine. There has recently been a notable addition to the industry in the shape of a cigarette paper manufacturing unit in the Greater Calcutta area. Care is taken for sealing and scientific packings by using transparent papers to make them moisture proof ; most of the cigarette factories are located in Calcutta, Bombay, Baroda, Allahabad, Monghyr, Jullundur and Hyderabad.

Cigar. Madras specialises in cigar manufacture, which is different from cheroot in shape. The quality of leaf used for cigars, as well as the value of ready product, is much less than of the cigarettes. Cigar manufacture is simpler than the cigarette manufacture and may be done by an elaborate machine. The quality of cigar depends on the leaf which is wrapped on it. The filler leaves used are of Trichinopoly origin and occasionally also from Guntur. The process of cigar manufacture consists of rolling, pasting the tip ends and heating at 150° to 160° of temperature to ensure its safety from insects.

Although manufactures in India are concentrated in the Madras State but over the past few years both West Bengal and Orissa have started making cigars and cheroots.

---

1 Cigarette paper is being produced by the Eastern Tissues Ltd., Raniganj and Tribeni Tissues Ltd.

There are seven factories in Madras, fifteen in Dindigul and nealy 400 small cottage-type establishments in Tiruchinapalli.

Cheroots. Madras is the main cheroot manufacturer. The average annual output of cheroots in India is estimated at 60-92 million lbs. or 18,500 million cheroots valued at over 9 crores of rupees. Thus it is more important than the cigarette manufacture.

Cheroot making is practised as a cottage industry. Rolling of cheroot and management of business is always done by woman labour. The quality depends on the coloured leaf wrappers, filler lead and flavour. The Madras cheroots are large, thin and dark-coloured.

Bidi is a cheap smoke. Bidi cheroots are large thin and Northern as well as Southern India. Its importance is both as an indigenous as well as commercialized industry. Over 55,000 million bidis are annually manufactured in India using about 70 million lbs. of tobacco. The total manufacture is estimated at 7.5 crores of rupees.

The manufacture of Bidis is more popular in the Deccan than in Northern India. Almost all the large towns in India are large centres of bidi industry. Poona is considered as pioneer of bidi manufacture in South India. Bhandara district in M.P. has special advantages for bidi industry. Cheap and plentiful supply of wrapper leaf and labour gives vitality to the industry there, Jabalpur, Gondia, Nagpur and Kamptee are the leading and controlling centres of industry. It is a flourishing industry in Madhya Pradesh and gives employment to over 42,000 persons. Bhandara district alone employs about 31,000 people.

Cheap tobacco with mixtures is used for bidi filling, thus making it cheap. The Deccan forests abound in the wrapper leaves, which are obtained at a very low price. The process of bidi making is simple. The wrapper leaves are first moistened to facilitate folding. Moistening of leaves is done at night to begin with the work during day time. Drying of the packets is the final process under artificial heat. Packing is done on contract for the sake of economy in production.

Hookah Tobacco. It is an important smoke for Northern India. All towns and villages manufacture *Hookah* tobacco. Delhi, Lucknow, Rampur and Gorakhpur are the chief centres. Annual output comes to about 6 million lbs.

There are two types of *hookah* tobacco, one is '*karuwa*' and the other '*mitha*'. Cured bobacco plant is dried and powdered. This powder is mixed with the jelly obtained from semi-used molasses. The kinds of '*karuwa*' or '*mitha*' are made according to the proportion of mixture and various ingredients to give smelling and taste. Preparation of 'khameera' takes a longer time to be useful. Manufacturers use adulterants for making it cheap.

Chewing Tobacco. Zarda, Qiwami or *Danedar* are the chief chewing tobaccos in the market. Delhi, Lucknow and Varanasi are the most

important places of manufacture. The leaves are boiled in lime water and then dried and scented. Chewing tobacco is also used raw by the villagers. Over 156 million lbs. of chewing tobacoo leaf valued at a little over 3 crores of rupees is annually consumed in the country.

The Snuffs. The manufacture of snuffs also extends all over India. The annual average production in India is estimated at 21 million lbs. valued at about a crore and a half of rupees.

There is a Central Tobacco Research Institute at Rajamundry for fundamental research on all tobaccos, a cigarette tobacco Research Station at Guntur, a Beedi Research Station at Anand and the main Experimental Research Station for Cigar and Cheroot tobacoo at Dindigul and chewing tobacco Research Station at Pusa (Bihar). A sub-station for hookah and snuff tobacco has been established at Ferozpore and a sub-station for beedi at Nipani.

RUBBER INDUSTRY

During the recent years, rubber has been gaining increasingly in importance and in every sphere of life and in war and peace, rubber plays a vital part. The rubber manufacturing industry procuring as many as 32,000 different articles of which tyre and tubes make up over 75 per cent has gradually established a position of great importance during the past two decades.

In India, the rubber manufacturing industry is just over three decades old. Though it started in the early twenties of the country, it had to struggle hard against foreign competition during the early stages of its career. The industry, however, received a great fillip during the Second World War and many new manufacturing units started as a result of the war stimulus. Despite renewed foreign competition during the post-war years, the Indian rubber industry has now been able to consolidate its position to a large extent.

At present the industry is made up of nearly 100 units, big and small and nearly 400 small units organised on cottage industry basis, with a total invested capital of about Rs. 16 crores and offering lucrative employment to well over 20,000 people. The inclusion of the rubber manufacturing industry as a scheduled industry under the Industries Act 1951 testified to the national importance of the industry.

In respect of raw rubber suplies, India is very nearly self-sufficient but not quite so as in 1953 and 1954. While the consumption of our industry was well over 25,000 tons, the production did not exceed 22,100 tons—there was thus a deficit of 2900 tons. To give relief to the rubber growers, the Government have introduced statutory price control import restrictions and other such measures under the Rubber Act. The Government have also appointed a Commission to investigate the financial conditions and other problems of the industry.

Production

Apart from 400 smaller units, there are at present 89 organised units in the manufacture of wide range of rubber goods. The rubber goods manufacturing industry in India covers the manufacture of 130 diverse items. About 85 p.c. of the raw rubber is consumed by the three important items, namely, automobile tyres and tubes, bicycle tyres and tubes and rubber footwear. The following table shows the production of rubber industry in India.

TABLE : *Production of Rubber Industry in India*

Product	1958	1959	1961	1962
Footwear (Lakh pairs)	367.2	392.4	451	497
Toys, Balloons *etc.* (lakh doz.)	242.4	289.2	256	..
Tyres				
Automobile (000)	1005.6	1138.8	1562	1709
Cycle (000)	8256.6	9511.2	11,346	11,839
Tractor (No)	2328	1836	48,456	56,556
Aero (No)	2328	1836	2652	3064
Cab (thousand ft.)	274.8	216.0	40	48
Tubes			*(thousand*	*metres)*
Automobile (000)	946.8	1124.4	1448	1522
Cycle (000)	7754.0	9950.4	12,674	11,574
Tractor (No)	31,123	34,968	53,724	53,748
Aero (No)	1,140	1,058	2148	2940
Hoses				
Radiator (000)	168.0	214.8	250	284
Vacuum Brake (000)	602.4	470.4	..	..
Other types (000 ft.)	9217.2	11440.0	..	..
Fan Belt (000 s)	666.0	1040.4	..	..
Ebonite (000 lb.)	234.0	253.4	167	1356
			thousand	kms.
Waterproof (000 yds.)	3336.4	3626.0	4732	4259
Latex foam sponge (000 lb.)	2226.0	2391.8	1517	1684

Trade

Export of raw rubber has now been completely stopped; considerable quantities are being imported to meet the increased domestic demand of the manufacturing industry. Reclaimed rubber, particularly the Alkali

whole tyre rubber is being increasingly used in India but the country has to depend upon its imports to the fullest extent. Again with the development of new lines of rubber components having resistance to oil and petrol, by intense heat and cold conditions, the consumption of Synthetic rubber in India is also on the increase. The most common types now in use being silicone and Butyle which are also coming into the field gradually. The entire requirements of the Synthetic rubber are obtained from the U.SA. In respect of most of the compounding ingredients, the Indian rubber manufacturers have to depend upon imports. Sulphur and carbon black come from the U.S.A. It is, however, encouraging to learn that some quantity of S. R. E. black is now being made inside the country. The establishment of the oil refineries is expected to help in the development and production of Carbon black at least to meet part of our requirements.

QUESTIONS

1. Discuss fully the geographical and economic background of the glass manufacturing industry in India.

2. Analyse the geographical factors responsible for the localization of cement industry in India.

3. Examine the basis of Indian manufacturing industry with especial reference to supplies of power and raw materials.

4. Give an account of the location, progress and future prospects of any one of the following industries in India; (1) Jute, (2) leather (3) plastic (4) paper.

CHAPTER 30

Chemical Industry

The changing pattern of the Indian economy has been substantially influenced by the chemical industry of the country. Today in India not less than three hundred industrial enterprises are concerned in the production of about a hundred different items of chemicals which have won for themselves a reputation for quality in the near and distant places of the world.

The Indian Chemical Industry is one of the newest on the continent of Asia. The industry produces and markets a great number of chemical products ranging from those obtained from nitrogen synthesis and from the processing the coal, superphosphates *etc*. The range of products also includes dyestuffs and intermediate substances, pharmaceuticals, auxiliary textile products, soap, glycerine, perfumery, paints and varnishes, artists' colours, manufactures of rubber, explosives, adhesives, gelatine, photographic materials, synthetic resins and plastics. The industry uses an important part of the sulphuric acid manufactured in the country in the manufacture of Sodium Sulphate, Potassium Sulphate, Copper Sulphate and artificial textile fibres.

The capital investment in the Indian Chemical Industry is estimated at about Rs. 40 crores. It affords employment to more than 35,000 workers and executives and puts to advantage talent and experience of Indian technologists. The industry produced goods worth 2 crores (for exports) in 1957 and since then the annual production has been on the increase.

The manufacture of heavy chemicals is not advanced in India, even though some of the raw materials of this industry are found here. The manufacture of acids, alkalis and their salts forms the background of heavy chemical industry. India is poor in sulphur which is the basic component of the heavy chemical industry. At present all sulphur needed by us is being imported either from Sicily, Japan or from U.S.A. To replace totally or even partially this imported sulphur, India can only fall back upon the scanty deposits of pyrites near Simla. Still more inaccessible deposits in Assam and comparatively good deposits of gypsum in Madhya Pradesh are also available. The other source, not of any considerable magnitude, is in the recovery of sulphur oxide produced in the roasting of copper ores near Ghatsila which produces about

7,000 tons per year. Another source that is tackled even in highly industrialised countries abroad is coal. But our coal is poor in sulphur, except the deposit of a tertiary nature in Assam, where the organic sulphur content is very high.

The impetus given by the War has resulted in considerable progress in heavy chemical industry in India. The production of soda ash, chlorine and bleaching powder has now begun here. A factory for bleaching powder at Rishra, and for soda ash at Port Okha have been started.

Chemical industry may be divided into two categories :—

(1) Heavy chemical industry.

(2) Fine chemical industry.

HEAVY CHEMICAL INDUSTRY

India is backward in the production of heavy chemicals. One of the reasons for this backwardness is the lack of suitable raw materials in required quantities. India does not possess industrial salts, sulphur, or copper in any considerable amount. Without heavy chemicals, however, not only is the general industrialization of the country impossible, but the artificial manures necessary for increasing the yields of agricultural crops cannot be obtained. The ammunition for our armies is also supplied by heavy chemicals. The starting of the heavy chemical industry was, therefore, considered essential for the progress of the country.

There are a number of Smaller Works where different kinds of heavy chemicals are manufactured, especially with imported raw material. Trivandum, Calcutta, Kanpur and Asansol are among the most important places for this production.

Heavy chemicals refer to those chemicals which are produced in large quantities, usually at low cost and which serves as raw materials for other industries. Heavy chemicals thus include mainly sulphur and its compounds, acid, soda ash, caustic soda and phosphates and ammonium sulphates. These are largely used in textiles, leather and paper industries. These heavy chemicals are at present manufactured at Calcutta, Bombay, Kanpur, Madras, Bangalore, Delhi and Amritsar.

Sulphuric Acid

Sulphuric acid is essentially the most important of all the chemicals and is largely used in leather tanning, textile finishing, oil refining, filling the accumulators, pickling of Iron and Steel before galvanising and tinning, for ordnance requirements in the production of explosives and cleaning of brass, bronze and copper sheets and wires.

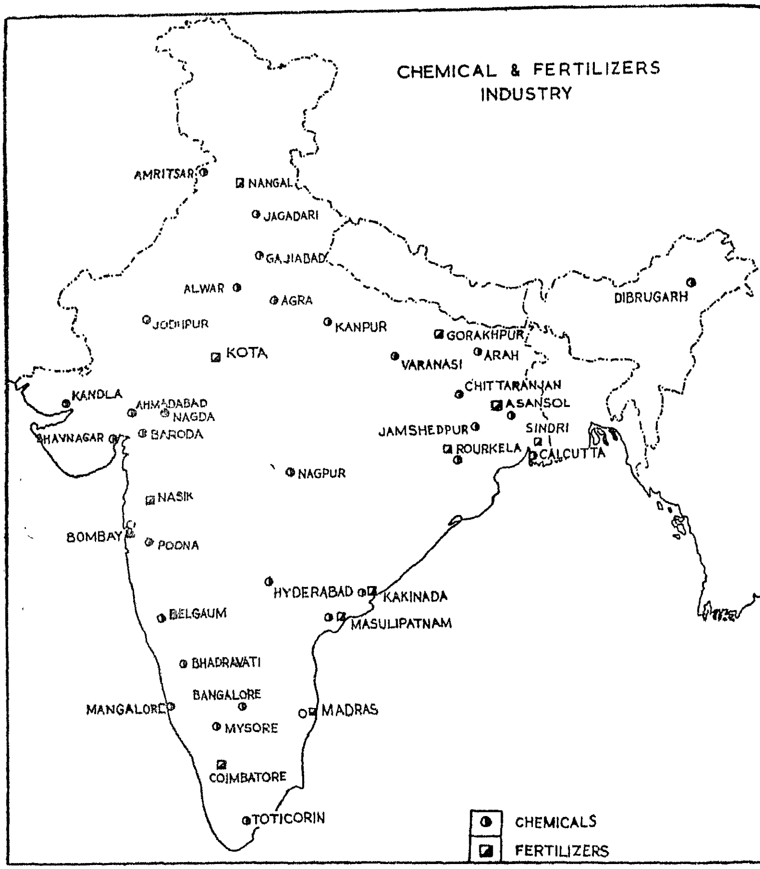


Fig. 66. Important centres of chemical industries in India

PRODUCING CENTRES

Forty four units are engaged in the production of Sulphuric acid and eight of them are equipped to manufacture concentrated acid by the contact process. One of them produces chlorohydrine, an indispensable reagent for the growth of the inorganic chemical industry.

Sulphuric acid is manufactured at various places, especially at the Tata Works in Jamshedpur, Digboi Oil Company Works in Assam and at the Mysore Chemical and Fertilizer Works. The chief of the producing firms are the following—

	Capacity in tons
Shaw Wallace & Co., Calcutta	8,250
Delhi Cloth Mills, Delhi	14,850

Century Rayon's, Bombay	7,140
Fertilisers & Chemicals, Travancore	60,000
Bihar Govt. Super-phosphates Factory	8,250
Dharmsi Morarji Chemicals Company	16,500
Hindustan Steel Ltd., Durgapur	19,800
J. K. Cotton Spinning & Weaving Mills	8,250
Atul Products, Bulsar	8,250
Indian Explosives, Goviya	3,300
Kasuram Rayon's, Calcutta	8,250
Anil Starch Products, Ahmedabad	9,000
Andhra Sugar Ltd., Tanuku	16,500

Production

There were twenty three factories in India before the war manufacturing sulphuric acid. Most of them were started during and after World War II. Considerable increase in the production capacity of sulphuric acid was achieved during 1951-55 through the installation and —or expansion of over ten contact sulphuric acid plants. Starting with a monthly rated capacity and output, in thousand tons, of 6.7 and 5.0 for 1946 and 1947, they expanded from year to year to 8.3 and 6.7; 12.5 and 8.3; 12.5 and 8.5; 16.8 and 8.9; 16.0 and 8.0; 15.8 and 9.1; 16.4 and 12.6 in 1954. The following table shows the production of Sulphuric acid in India.

TABLE CXLII: *Production of Sulphuric acid*

Year	Production (000 tons)
1952	96,084
1956	165,216
1957	193,068
1958	227,016
1959	275,124
1960	353,940
1961	413,520
1962	458,304
1963	485,000
1964	602,000
1965	695,000

CAUSTIC SODA

It is used in many industries like rayon, soap, textiles, paper, oil refining, other chemicals, rubber reclaiming *etc.*

Caustic Soda is manufactured especially in Calcutta, Methur, Mithapur and Ahmedabad *etc.*

At present about 15 factories are producing caustic soda and there has been further expansion in rated capacity and monthly output. The following table shows the producing of caustic soda in Indian Republic—

TABLE CL : *Production of Caustic Soda*

Year	Production (tons)
1952	17,064
1953	22,908
1954	29,304
1955	34,248
1956	39,420
1957	42,648
1958	57,192
1959	68,744
1960	23,144
1961	119,844
1962	126,432
1963	130,000
1964	163,000
1965	192,000

India is backward in the production of caustic soda. The import policy and the high prices since 1951 gave an impetus to this nascent industry though the heavy imports allowed in the first two years of the First Plan caused some temporary difficulties to indigenous producers owing to accumulation of stocks. The actual imports in tons were 1951 : 52,101; 1952 : 112,147; 1953 : 355,06; 1954 : 945,44; 1955 : 65,996; 1956 : 90,966; 1957 : 84,711; 1958: 50856; 1959 : 126,559 and in 1960 : 40,952.

Soda Ash

The Soda Ash industry constitutes an important branch of the Indian Chemical Industry. It may be remembered that the manufacture of Sodium Carbonate is one of the oldest industry in India, where that product has always been in great demand especially by the glass-making industry.

Two factories are currently engaged in the production of Soda ash. While the monthly capacity stood at 4,500 tons between 1948 and 1952, the output rose from 1,000 to 1,135; 2429; 1993; 3649; 3961 and

3694 tons during succeeding years. In 1953, the capacity was expanded to 5100 tons and the units manufactured 4739 tons and 4024 tons per month in 1953. It has been since expanded to 7500 tons and the average monthly production has improved further to 6110 tons. In 1959 the total capacity was 110,000 tons.

The following table shows the production of Soda ash in India.

Year	Production
1952	44,328 tons
1953	56,838 ,,
1954	48,288 ,,
1955	77,268 ,,
1956	84,240 ,,
1957	91,927 ,,
1958	89,436 ,,
1959	95,328 ,,
1960	145,284 ,,
1961	176,640 ,,
1962	222,660 ,,
1963	236,000 ,,
1964	274,000 ,,
1965	286,000 ,

Three integrated chemical plants in the public sector with initial capacity of 230,000 tons were set up at Varanasi, Neyveli and Porbandar.

Liquid Chlorine

The electrolytic manufacture of caustic soda produces chlorine as by-product For every ton of caustic soda produced, 0.88 ton of chlorine is made. It is mostly used in chemical and pharmaceutical industries.

There were at the end of 1965, 12 units manufacturing chlorine with an annual capacity of 36,000 tons. There is a number of smaller and big works where chlorine is manufactured, specially at Calcutta, Bombay, Delhi and Madras.

A new factory of Dhrangadhra Chemical Works went into production in 1959 with an initial capacity of 30,000 tons per annum which is to be increased to 55,000 tons. The expansion of Tata Chemicals is being implemented.

The following table shows the production of Chlorine in India.

Year	Production (ton)
1952	6,240
1953	8,133
1954	9,780
1955	11,580
1956	15,072
1957	15,969
1958	19,824
1959	24,780
1960	31,656
1961	33,912
1962	36,972

Calcium Carbide

Calcium carbide is used by certain firms for the manufacture of acetylene which is delivered in solution form in steel cylinders.

Five factories manufacture calcium carbide, one of these units transforms its entire production into cyanide. The production of calcium carbide by the two units one each in West Bengal and Madras, stood at 3,803 tons in 1958. Their rated capacity as on Jan. 30, 1961 aggregated to 16,939 tons as against 4,116 tons in 1958. Another unit in Maharashtra with a capacity of 14,228 tons was expected to start production in Feb. 1961. Two more units, one each in Delhi and Kerala, have been estimated at 56,537 tons in 1964.

FINE CHEMICALS

The term "fine chemicals" is applied usually to substances such as photographic materials, drugs and pharmaceutical products, paints, pigments and varnishes and dyestuffs.

Coal-tar chemicals form the foundation of the organic chemical industry from which benzole, anthracene and anthracene oil are obtained for use in dyes, explosives, perfumes, flavouring essences, plastics, pharmaceuticals and photographic chemicals. The manufacture of coal-tars is concentrated in Kulti, Bombay, Calcutta, Jamshedpur, Hirapur and Sindri.

Even before the war, the existence of numerous coking-plants permitted the utilization of liquid by-products from the coking of coal tar, recovery of benzol, tar distillation. After the war, the industry of Synthetics came into being to make further use of gases produced in coal coking. The development of the Synthetic ammonia industry has

enabled the other constituents of coking gas to be utilized, and has resulted in the manufacture of ethylene derivatives in India. These are Glycols, Ethanolamines *etc.*

The existence of an important synthetic menthol industry has led to the manufacture of succession of menthol derivatives such as formaldehyde and in consequence, all the formaldehyde is an important constituent.

Mention must also be made of an important production of starch extracted from certain cereals and tubers which is intended for the manufacture of glues and textile dre sings. Resins of the bakelite type, urea-formol resins, moulding powders were manufactured in India after World War II but not in large quantities. This branch of the industry has since continued to develop and expand.

For a long time industrialists have been endeavouring to discover how to put to best use the considerable quantities of tar from which are derived well-known raw materials such as benzene, toluene, naphtalene, phenol-cresol, anthracene, carbazol and few others. A number of factories have commenced manufacture of intermediate products obtained from these raw materials and have advanced their specialization to produce finished products with the result that the derived phthalic anhydride maleic an hydride, and alkoid resins now constitute an important branch of the Indian Chemicals Industry, as does the manufacture of dyestuffs and organic pigments.

Photographic Materials

The basic chemical required for the photographic industry are—(i) gelatin silver halides and sensitizers in the coating of film, plate and paper base, and (ii) hyposodium sulphite metal, hydroquinone and chrome alum in the processing stages.

Borax, boric acid, acetic acid and metal and photographic-grade sodium sulphite are still imported.

The Hindustan Photo Films Manufacturing Co., Ltd., was registered in Madras on the 30th Novermber, 1960, with an authorised capital of Rs. 3 crores, subsequently raised to Rs. 4.2 crores, for setting up at Ootacamund a plant for the manufacture of raw films for cinema industry, photographic papers, and films and X-ray films in technical collaboration with a French firm. The factory was inaugurated on Jan. 7, 1969 and is the largest of its kind in Asia.

Another factory has been started at Ootacamund for the manufacture of various kinds of photographic materials in collaboration with a French firm. The Government of India have entrusted the implementation of this project to Hindustan Photo Films Manufacturing Co. Ltd.

Another remarkable activity is the production of spcialized equipment to manufacture products through injection and extrusion of plastic materials.

FERTILIZERS

In 1943, the Foodgrains Policy Committee of the Government of India advised that, in future, India would require two to three million tons of nitrogenous fertilizers, costing about 70 crores of rupees per annum. It recommended immediate action to establish a factory for nitrogenous fertilizer. Realising the importance of this industry as a defence potential, the War Resources Committee resolved at the end of 1943 that the Government should undertake the responsibility for such a factory as a nationalized industry. During the next few months steps were taken to start the artificial fertilizer industry at Sindri near Dhanbad in Bihar as it had the advantage of water supply facility of getting the raw material, and its situation near coal mines. The two most important requirements of the fertilizer industry are the supplies of gypsum as the raw material, and plenty of water. Gypsum was expected from the Salt Range of West Pakistan. As a large amount of coal was being sent to the Punjab, considerable number of wagons were returning empty to the coal mines. The cost of transport of gypsum supplies to Sindri was, therefore, expected to be low. Due to the partition, however, the Salt Range gypsum could not be depended upon. Luckily, large amounts of gypsum occur near Bikaner and Jodhpur. These are being developed and about 1 lakh tons have already been stockpiled at Sindri. The main difficulty is the transhipment at Agra where the broad gauge changes to the meter gauge. When in full operation, the Sindri Fertilizer Factory would require about 2,000 tons of gypsum every day.

The water requirements of the factory are estimated to be large, about 12 million gallons per day. These are supplied from :—

(i) An artificial lake built by a dam on the Goa river which is a tributary of the Damodar joining it about four miles upstream from Sindri;

(ii) An Infiltration Gallery to tap the water available in the sands in the bed of the Damodar when the surface flow diminishes; and

(iii) The Pumping and Purification Works on the Damodar river.

The factory itself can be divided into four main groups, namely, (i) Power House, (ii) Gas Plant, (iii) Ammonia Synthesis Plant and (iv) Sulphate Storage Plant. The power-house contains the complete plant for generating power for the factory and the supply of process steam. The power-house supplies not only power and steam

for process work necessary for the operation of the factory, but also exports power to the D.V.C. grid, for the much-needed expansion of coal mining, and for industry development generally in the Damodar Valley area, including the big Chittaranjan Locomotive Workshop at Mihijam near Asansol.

Production

The Sindri Fertilizers went into operation in 1951. In 1960-61 it produced 3,05,218 metric tons of ammonium sulphate. The scheme to raise the output by about 60% has been completed at a cost of about Rs. 15 crores and is expected to produce 70 tons of urea and 400 tons of ammonium sulphate nitrate per day. In 1960-61 the factory produced 10.6 thousand metric tons of urea and 36 thousand metric tons of double salt *i.e.*, ammonium sulphate nitrate.

In 1965, it produced 246,722 tons of ammonium sulphate compared to 2,23,960 tons during the corresponding period in the preceding year. In the same year the factory produced 14,755 tons of urea and 37,898 tons of double salt, compared to 12,682 and 33,593 tons respectively. A bean gas plant and a naphtha gasification unit are being installed to increase the production by 20,000 tons per year.

To meet the anticipated demand for nitrogenous fertilizers a factory is being set up at Nangal for the production of nitro-limestone and heavy water. The fertilizer part of the factory was completed in February 1961 and has produced 2,80,510 tons of calcium ammonium nitrate in 1965. Additional units are to be set up at Neyveli, Rourkela, Trombay and Naharkatiya (Assam).

The Rourkela fertilizer factory, an adjunct of the Rourkela Steel Plant, has a rated annual capacity of 5.8 lakh tons of calcium ammonium nitrate and was commissioned on trial basis on December 1, 1962. Another unit set up at Neyveli with a capacity of 71,000 tons of nitrogen and integrated with the Neyveli Lignite Corporation has been under trial runs, to commence regular production in March 1966.

A private sector factory at Ennore (Madras) with a capacity of about 8,000 tons of nitrogen, went into production in January 1963.

The Fourth Plan target of nitrogenous fertiliser is proposed at 24 lakh tons a year. Licences have also been granted for the setting up of fertilizer plants of different capacities at various places such as Visakhapatnam,Kothagudam (Andhra Pradesh) Baroda (Gujarat), Kotah (Rajasthan), Goa and Kanpur.

PLASTIC INDUSTRY

The Plastic industry, which made a modest beginning in this country less than two decades ago, has made rapid progress since.

The industry is playing a vital role in the steady growth of the country's economy. Large quantities of plastics are being used for

industrial and constructional applications.

In cable industry, for instance, polycinyl chloride and polyethylene insulation is reducing cost and maintenance to a considerable extent. In agriculture and horticulture, plastics are used increasingly in piping schemes as they provide cheaper and more efficient irrigation.

Plastics are also used in the foundry, machine shop, building, aircraft, shipping and various other industries. They are cheap, versatile and strong and their properties may be altered to meet specific requirements.

Tooth-brushes, combs, toys, refrigerator components, radios, fans, and a host of other articles are made out of plastics.

Raw Materials. The principal raw materials required by the industry, such as polystyrene, polyethylene, phenol formaldehyde and urea formaldehyde, moulding powers are now manufactured in this country. Although, at present, these manufacturers may not be able to meet the full requirements of the industry both in respect of quantum and quality, it is expected that in the course of the next few years supplies would be adequate for our industry's requirements in all respects both for domestic as well as export purposes.

Besides, it is expected that in the near future other raw materials, very potential for this industry's requirements such as p.v.c. composition and resins and plasticisers, cellulose acetate moulding powders and other will also be available from indigenous manufacturers, for the manufacture of which plants are being put up.

Production

Today it is definitely one of the country's important and developing industries. The industry which is mainly centred around Bombay, Calcutta, Amritsar, Kanpur, Hyderabad and Coimbatore, is making considerable advance in other parts of the country as well, and now we have plastics manufacturing factories springing up in all parts of the country.

The range of manufactures of plastic items at present in this country include consumer and utility goods which are used in the different sections of a home, desk table materials, stationery *etc.*, which cater to the requirements of schools, colleges, offices, hospitals, *etc.*, houses, sun glasses, garden furniture *etc.*, which are of great use in outdoor life, and industrial applications such as electrical accessories, p.v.c. covers for motor car and cinema seats, refrigerator and air conditioning accessories, insulation materials *etc.*

Production of various essential plastics raw materials has already been undertaken in the country. There are five units producing phenol formaldehyde moulding power. The total production of this raw material was 2040 tons in 1960 as against 1810 tons in 1959. Two factories

are engaged in the manufacture of urea formaldehyde moulding powder with a rated capacity of about 1000 tons per annum. The production of this raw material was 353 tons in 1960 as against 321 tons in 1959.

There is at present only one unit manufacturing polystyrene moulding powder. While the rated capacity of this firm is 5400 tons, production in 1960 was about 3500 tons. Two polyethylene plants are in production with a total rated capacity of 6,200 tons. Both these companies have been granted industrial licences for substantial expansion amounting to about 17,500 tons. The production of polyethylene was 5000 tons in 1964. At present there is only one unit producing polycinyl chloride. The rated capacity of this plant is 3600 tons. This plant went into production in September 1964. The plant of Messrs. Rajasthan Vinyls went into production in 1962.

Export

Plastic industry in India has made substantial progress during recent years and is producing a wide variety of industrial and consumer items not only to cater for the full home demand but also to export part of its production. The former reliance on imports of raw materials has, to a large extent, been eliminated by setting up various raw material plants in the country itself.

Though small quantities of plastics were being exported since the beginning of 1951, it was only after the formation of the Plastics and Linoleun Export Promotion Council that concerted and systematic efforts have been made to increase the tempo of plastics export trade.

The following export statistics will indicate the performance of the industry during the last seven years.

1957-58	1,987,098
1958-59	2,778,009
1959-60	7,366,500
1962-63	1,049,990
1963-64	2,640,000

Plastics goods which are exported include, amongst others, leather cloth, spectacle frames, fountain pens, umbrella handless, bangles, belts, electrical accessories, buttons, combs, footwear, trays, moulded goods, tumblers, inhalers, brushes, containers, bags, diaries and so on.

The countries to which our plastics are being exported cover the East African, Middle East, West Asia and South-East Asian ountries, where not much industrial development had taken place. These may fairly be called our traditional markets.

However, during the past three or four years, our exports have been getting diversified and some items of manufacture have found it possible

to break into U.S.A., U.K. and the west European markets as well. These items, however, are limited to such as p.v.c. leather cloth, spectacle frames and bangles at present.

Prospects

It is, however, hoped that in the coming years the exports of several other items of Indian manufacture could be made quite successfully and in substantial quantities to these advanced countries as well.

Paint Industry

A commodity like paints and varnishes has innumerable uses. The demand for paints and varnishes arises mainly from railways, building operations and industries like automobile, bicycle, electrical equipment, engineering *etc.*

Historical Development

The paint industry is another important chemical industry in India. This industry had its beginnings here as far back as 1902, when the first commercial factory was established at Goabaria, near Calcutta, and for several years after, this pioneer factory continued to be the only producer and did much valuable research work in establishing the fact that the Indian products could compete favourably with imported articles of paint. With the outbreak of the Great War of 1914, not only were imports restricted but there was a considerable increase in the demand for paint products. As a result of this situation there are today about a dozen factories manufacturing paints and varnishes, *etc.*

The real development of the industry, however, dates back to a recent date. It is only since 1937-38 that the imports of plants and their products have decidedly declined. Simultaneously with this, the Indian products have shown a steady rise. But even now the imports of paints and painters' materials account for considerable import into the country.

Raw Materials

The most important problem is that of raw materials. On present indications, the industry for quite some time to come is not very happily placed in this regard. The paints industry is importing its entire requirements of tung oil, mostly from China.

Raw materials like linseed oil, rosin, turpentine, castor oil, methylated spirit, shellac, *etc.*, are available in this country, but most of the pigments and extenders have as yet to be obtained from outside—in some cases even imported from foreign countries.

The supply position of rosin and turpentine too are satisfactory. In the latter the production is actually more than the demand. In the case of certain superior quantity of rosin, however, like W.W. grade, the supply is falling short of demand currently. It is to be hoped that this is a transitory phase.

Most of the oils mentioned are in extensive use in the paints industry, while some others could be put to better use by suitable modifications in their properties.

Apart from the above mentioned raw materials there are many others in which the paints industry is more or less wholly dependent on imports.

The following table shows the yearly production of paints and varnishes for recent years :—

1950	27,948 tons	1956	41,424 tons
1951	33,492 „	1957	42,276 „
1952	32,172 „	1958	47,832 „
1953	32,052 „	1959	54,240 „
1954	36,816 „	1960	50,716 „
1955	39,036 „	1961	57,864 „
		1962	64,428 „

We import large quantities of paints and varnishes especially dyes (from coal tar) in enormous quantities.

Prospects

The market for paint products at home is rapidly expanding and will continue to do so as general industry expands. Improved living standards will offer a greater public consumption. A further market must be expanded and that is the export field. The quality of the Indian products in many fields is equal to that of those being exported from other countries and India has a geographical advantage offering reduced shipping costs.

QUESTIONS

1. Discuss fully the prospects of developing the heavy chemical industries in India.

2. Discuss the localization of the heavy chemical industry in India and trace generally the influence of this industry on the development of other industries.

CHAPTER 31

Industrial Regions of India

India now has many important centres of industry heavy and light, several other areas where modern mining or manufacturing is under way.

The factors that have influenced the location of industrial regions of India are many and various. During the rapid industrialization of twentieth century one of the most important influences was the proximity of coal, the major source of power, particularly when it was associated with ease of access to other raw materials such as Iron ore in Bihar and Orissa (for Iron and Steel) in Jamshedpur and in the east, which in turn offered easy access to imported raw materials and a quick outlet for exports. The main areas of industrial concentration are still, with one exception (Calcutta), the areas which saw the beginning of India's industrial greatness and which, with two exceptions (Calcutta and Jamshedpur), are on or near coafilelds; but many smaller and more widely dispersed centres of industry have grown up, notably in Ahmedabad and Punjab.

India is industrially a backward country, yet there are certain areas which show, owing to the concentration of certain manufacturing industries, all the characteristics of industrial regions. These characteristics may be said to be :

(i) Large urban population;

(ii) Large banking facilities;

(iii) Integration of some main industry around which group a number of subsidiary industries ;

(iv) A network of communication lines; and

(v) A large market for labour.

Bearing these facts in mind, it cannot be said that every town or centre where some sort of manufacturing is done should be described as in 'industrial region'. This term should be reserved only for those areas which possess all the characteristics listed above. The underlying idea is that in an 'industrial region' a particular industry and the occupations depending directly upon it form the major source of the income of the people there. This criterion naturally leaves out from our discussion a large number of isolated places in India where manufacturing

industries, depending upon some local geographical advantages are carried on. Such, for example, are the places where a solitary cotton-ginning factory or solitary cotton mill may be working or where there may be a small glass factory or a cement or lime factory.

The following are, therefore, the main industrial regions in India:—

The Eastern Node

Easternmost of the manufacturing concentration is the Eastern node, whose principal urban centres are Calcutta and Jamshedpur. In 1961 the former had a population of nearly over 2,927,289 and the latter over 328,044. Nine important cities have a population between 28,000 and 512,598.

Calcutta is the most important industrial region in this node. A great variety of industries is carried on in Calcutta, but the main industries are jute, paper, iron and cotton. These industries are located mainly outside the congested town of Calcutta. Howrah, Lillooah, Belur, Dum Dum and Budge Budge are some of the important suburbs of Calcutta where these industries are carried on. The industrial sites have been selected mostly along the banks of river Hooghly which serve as an important line of communication with the town and port of Calcutta, besides the railways that serve Calcutta. An important feature which distinguishes the Calcutta industrial region from the Bombay industrial region is the quarters provided for the labourers near the factory itself. The long distance that ordinarily separates the factory from the Calcutta town makes this necessary; while the large areas of open land near the factories make the building of labour quarters possible. In Bombay, on the other hand, the mills are generally situated within the town in congested areas. The Chawls (the houses where the mill workers live in Bombay) are, therefore, part of the town.

The geographical factors have led to the rise of industries near Calcutta may be summed up as follows :

(a) *Situation at the head of the estuary and the Valley of Ganga.* On the one hand, this enables an easy contact with the sea facilitating the imports of machinery and the export of finished goods; and on the other hand it gives an access to the interior of the country through various railways and roads connecting Calcutta with the coalfields, the sources of raw material, the sources of labour supply, and the chief markets which require the articles manufactured at Calcutta.

(b) *Nearness to Coal.* Most of the coal produced in India is within easy reach of Calcutta. There is no other manufacturing region in India which is situated so near the coalfields as Calcutta. Coal is used in Calcutta industries for generating steam with which the machines are driven, and also for generating electricity which is used in the factories for numerous purposes.

37

(c) *Nearness to Raw Material.* Raw jute, the basis o the most important jute mill industry of Calcutta, is found near at hand. The raw materials for other industries like paper, leather, iron, chemical and textile industries can also be obtained from nearby places easily.

(d) *Labour Supply.* The dense population of the Ganga Valley is a vast source of cheap labour for Calcutta. Several places near Calcutta, like Murshidabad and Dacca, have been famous in the past for the skill of their textile workers. It is true that the modern factory today has no use for that type of skilled labour. But it cannot be denied that the old textile industries of Murshidabad and Dacca had brought into existence a group of workers who, because of their life- long work in textile industries, were able to pick up the new technique of manufacture quickly.

(e) *Market.* The vast population of the Ganga offers an immense market for things produced in this industrial region.

(f) *Economic Advantages.* The early start of banking facilities, the development of railways, the settlement of Europeans at an early date in Calcutta, were some of the economic advantages that helped the rise of industies in this region.

Except jute, which depends on foreign markets for its prosperity, all other industries carried on in Calcutta cater for the home market.

This industrial belt of Eastern region in Raniganj, Asansol, Kulti, Durgapur and Rourkela is continued westward along the centre toward Chittaranjan and Ranchi. Durgapur, a city of 41696 in 1961, has grown with extraordinary rapidity during the recent decade, as a consequence of the concentration there of industrial enterprises of a strategic nature. Primarily it is a centre of heavy industries with blast furnaces and Iron and Steel mills, chemical plants and the like. The manufacturing structure of the Eastern node is one of the great diversity. Until recently at least, Jute manufacturing led all other industries, though the recent expansion in metal and machinery has created serious rivals. After independence the Eastern industrial belt had greatly increased in importance, particularly in the heavy industries requiring large factories. Today it ranks high in blast furnaces, steel mills, machines and tools, chemicals, electrical machinery and loco-building *etc.*

The Western Coastal Region

This is the western end of a coastal manufacturing belt connecting Ahmedabad in the north Bombay in the centre and Poona and Sholapur in the South-east. By no means are these areas devoted exclusively to manufacturing, for they contain the homes of thousands of industrial workers, as well as local business centres. Throughout most of its history Bombay has been chiefly a port city and manufacturing has been

overshadowed by trade. One reason for the slow development of industry has been restricted area of level land suitabe for factory sites.

Bombay is the most important industrial city of this belt, its importance lies chiefly in the fact that the only truly 'Indian' industry, the cotton mill industry, in which the capital and the organisation are both India's, is centred at Bombay.

Bombay is, however, a small island with hilly area at its back. This limits the area of level land where factories can be erected. It is also far away removed from the coal-producing regions of India. Its advantage is in the fact that it is a port having a vast foreign and coasting trade. It can, therefore, import cheaply by sea whatever it needs. It has also good rail connections with the interior.

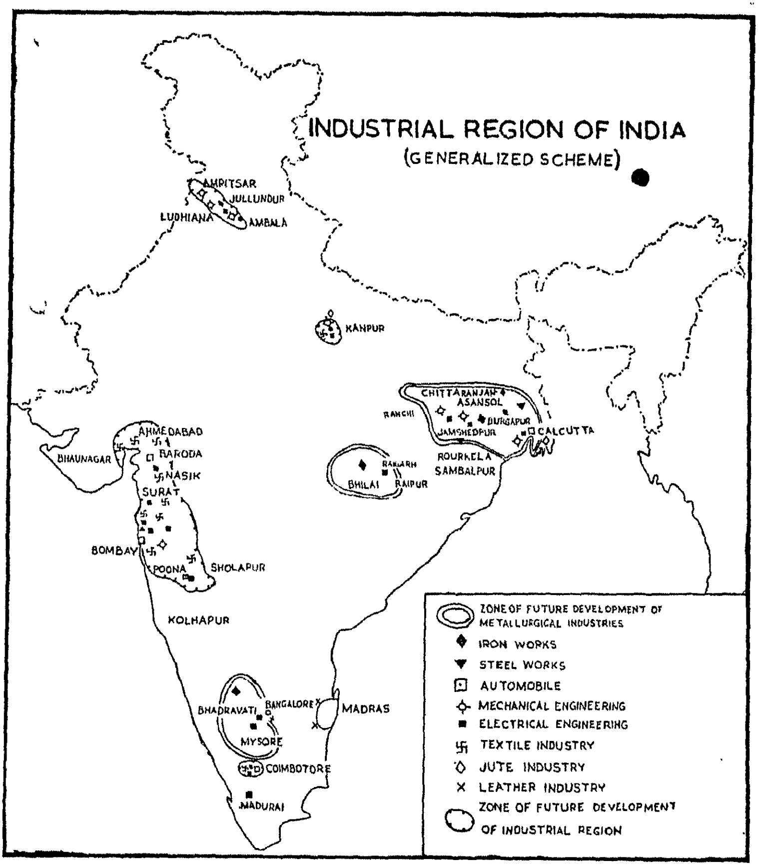


Fig. 67 Industrial Regions of India

A unique feature of Bombay is that in the neighbourhood of Bombay lies the most important hydroelectricity generating region of India. Bombay now, therefore, depends largely on this hydro-electricity for its industrial development.

The most important industries carried on in Bombay are the textile engineering and chemical industries.

Bombay (41,52,056) is the commercial hub of the cotton and man-made fibre textiles industries, a very important financial and commercial centre and a major port. It is also one of the chief centres of electrical and heavy engineering and the production of machine tools, petrol-refineries and chemicals, dyestuffs and pharmaceutical goods, while it has a wide range of other manufactures. Most of the cotton and other yarns are spun in Ahmedabad (1206,001), Baroda (298,398), Surat (288,026), Nasik (215,576) and at Broach (73,639); further to the South lie the cotton textile towns of Poona (737,426), Sholapur (337,583), Kolhapur (193,186).

Engineering industries, notably the manufacture of printing, paper-making, textile and electrical machinery and commercial vehicles are, however, more important to this industrial belt.

Madras Region

Among the difficulties which have tended in the past to restrict the development on a large scale of industries in Madras are the high price and scarcity of fuel, owing to the fact that nowhere south of Hyderabad has coal been found to exist in workable deposits. The hydro-electric and thermo-electric projects which have been completed or are under construction or contemplation will, however, go far to remedy the deficiency and admit of the exploitation of the natural resources of the state to the maximum possible extent. The extent of development of electricity will be realised when it is mentioned that during the last decade the number of units generated has increased from 20 million to 170 million units. Already, the possibility of establishing several important industries not thought of years ago, has been opened up by the advent of cheap electric power over a wide area of Madras, while the existing industries have been benefiting thereby in an increasing measure.

Madras is noted for chocolates and confectionery manufacture, one of the largest fishing ports and with many manufacturing industries, including vegetable oil, paints, glass, clothing and scientific instruments.

Coimbatore Industrial Centre

Coimbatore is another largest industrial city in Madras state. It has seventy one textile mills, 57 of which are spinning mills and the rest weaving mills. The spinning mills have a spindlage of 1,743,984 and

weaving mills 3,171 looms. All the mills employ approximately 55,000 workers of whom 12,000 are women. There are also 60 ginning factories with an additional labour of about 10,000 and the city itself is officially called the "Manchester of South India." It is the largest textile manufacturing centre with ring and mule spindles totalling 1,566,846 producing on an average 27,000 bales of yarn monthly.

There are also a number of Iron foundries, Coimbatore being the first in India to manufacture pump-sets for irrigation. A medium sized blast furnace is in operation. An associated cement factory produces 1,500 tons a day. A 22-lakh Synthetic gem factory, the first of its kind in Asia, was opened in 1957. The factory which is an Indo-Swiss venture, hopes to produce in the first year alone gems valued at Rs. 20 lakhs. Three factories in Coimbatore produce nut and plastic buttons; other specialised institutions are the Union Government's Sugarcane Breeding Institute, the Southern Herbarium of the Botanical Survey of India and the Regional Research Station of the Indian Council of Agricultural Research for cotton, millets and oil seeds.

North-west Industrial Region

Besides being one of the most productive agricultural regions, the North-western India possesses some sizeable towns. Amritsar (376,295) and Ambala (181,747) are notable for agricultural machinery and implements, Jullundur (265,030) for footwear and food manufacture. Food canning and freezing, based mainly on locally grown produce, have developed rapidly.

Industrial cities and towns lying within this industrial area include Ludhiana (244,032) noted for clothing (including hosiery and knitwear). There are about 950 hosiery units in the country of which nearly 800 units are situated in Ludhiana.

QUESTION

1. Divide India into industrial regions and give a brief account of any two of them.

CHAPTER 32

Transport

India is a vast country with a huge population, and yet the lines of communications are not as well developed here as they are in some of the countries of the West. The backward state of commercial development is its main cause. Until recently Indian economy has been characterised, more or less, by self-sufficiency in which transport played very little part. The development of communications in India is a feature of the modern times when her contact with the West brought about the development of a foreign commerce in which, unlike the commerce of the ancient times which was marked by light and precious goods, heavy goods predominate. Unlike the old foreign commerce which followed the land route, this foreign commerce in heavy goods passed through sea-ports which had, therefore, to be connected with the inland centres by modern means of communication.

The most important of the sea-ports on which the foreign commerce of the country concentrated, later became important industrial centres which necessitated a further development of communications between these ports and the inland towns, for their market as well as the source of raw material lay in the hinterland. The main feature of the communications in India is that they especially join the sea-ports to their hinterland, there being a marked absence of large industrial and commercial centres inland.

From many points of view, the railway is the most important means of transport in India. There are about 35,395 route miles (57,089 kms.) of railways open for traffic in India. This gives less than 30 route miles for every thousand square miles of area. This is insignificant when compared with some of the countries of Western Europe which are essentially industrial, but when compared with the essentially agricultural countries, the position is not so hopeless.

Of the total route mileage roughly about one-half is in the Indo-Gangetic Valley which, with its fertile plains and large population together with Calcutta, one of the biggest Indian sea-ports, naturally offers the most favourable conditions for railway development. Before partition at one time this Valley possessed the longest Indian railway (the N. W. R. 6,900 miles), the busiest Indian railway (the E. I. R. earning about 17 crores of rupees annually), and the most profitable Indian Rail-

way (the Shahdara Light Rly.) yielding about 10%, on an average between 1926-27 and 1935-37 and B. & N. W. R. yielding about 9% for the same period.

The general characteristic of the route in this valley is that it is straight over long distances. The absence of hills enables the railway line to run for miles without changing its course. But while the level nature of the valley helps the railway, rainfall and the numerous streams necessitating costly bridges are a drawback. The frequent floods also raise the cost of maintaining the track. The ballast for the railway track is available from the hills adjoining the Indo-Gangetic Valley.

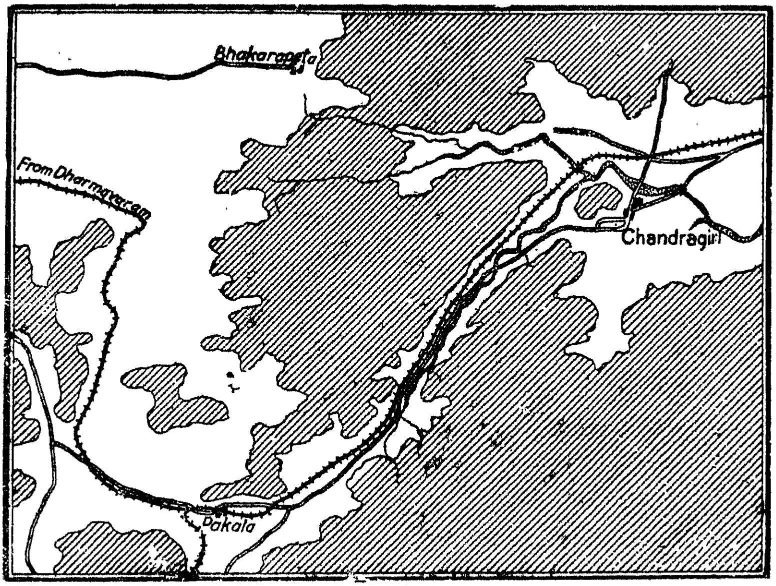


Fig. 68. Tapographic effects on transportation and Communication.

The railway lines in the Gangetic Valley are characterised by a large number of branch lines. The branches are particularly numerous in areas where the traffic is spread over the adjoining area. The best examples of such areas are the Raniganj and Jharia coalfields. There is no other part of India where the network of railways is so dense as in these two areas. The network of railways is denser in the Indo-Gangetic Valley than in the Peninsular India. The railway lines of the Indo-Gangetic Valley terminate at Calcutta while towards the north the Himalayas are a natural barrier to further extension. It is only near Darjeeling and Simla that the mountain railways have penetrated the outer ranges of the Himalayas.

The railway lines running in the Peninsular India are zig-zag as compared with the almost straight lines in the Indo-Gangetic Valley. The broken topography of the south compels the lines to change their course and gradient from place to place. The gradients are here much steeper than in the level plains of the Indo-Gangetic Valley. These steep gradients necessitate the service of a 'banking' engine at some places; as for example, near Hoshangabad and near Igatpuri on the old G. I. P.

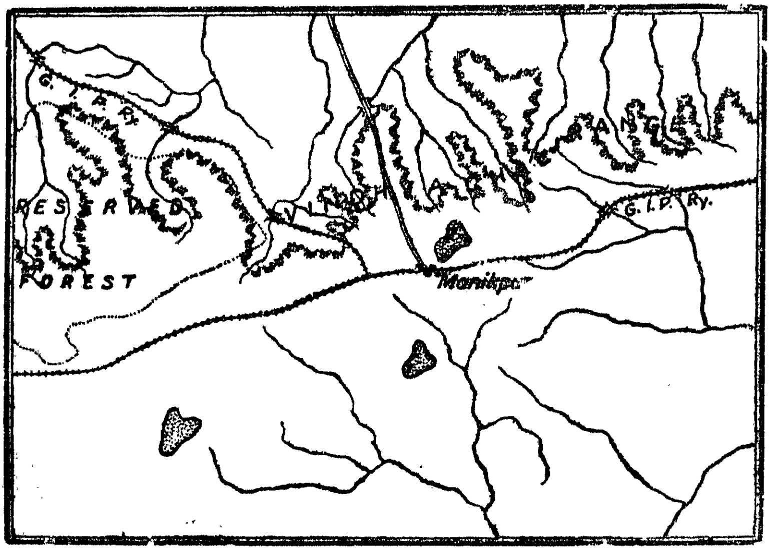


Fig. 69.

Railway. The broken and hilly nature of the Pensinsula also causes the making of tunnels at some places to get over the obstructions. The railway building is, therefore, a much more expensive business in the south than it is in the Indo-Gangetic Valley.

The control of relief on the direction followed by the railway line is very marked in the south. Sometimes, the railway line has to make a long detour in order to avoid some obstruction or to take advantage of some gap. In Fig. 69 it is shown how the ralway lines make detours to avoid crossing a number of streams which will need to be bridged. Fig. 69 shows how a railway line turns to avail of a narrow river valley which is used also by a road.

There are two large areas in India which are particularly deficient in railways. These are (a) the Thar and Rajasthan deserts and (b) the broken and hilly land of Chhota Nagpur and Orissa. These areas are very thinly populated and have very little need for railways.

INDIAN RAILWAY SYSTEM

The Indian railway system is the largest in Asia and second largest in the world. It is the country's biggest nationalised undertaking with a route mileage of 58,300 kilometres. The railways constitute India's principal means of transport and carry about 80% of the goods traffic and 70 p.c. of the passengers. In 1961-62 on an average about 46 lakh persons travelled in 4500 trains to or from 6400 railway stations daily. In 1961-62 the railways carried an average 4.4 lakh tons of goods daily. About 3.62 lakh tons of goods were carried by 3000 goods trains daily loading 23,000 wagons per day. The total capital-at-charge was about Rs. 1690 crores at the end of 1961-62, and the gross earnings were Rs. 502 crores. The railways employed about 11.76 lakh persons and paid Rs. 214.51 crores in wages and salaries.

With assets exceeding Rs. 3000 crores, the railways employ 13 lakh persons, have a fleet of 12000 locomotives, 31000 coaching vehicles and 3,58,000 wagons or freight cars, run 10,000 trains a day, operate over 6,800 stations, carry 50 lakh passengers and over 5 lakh tons of freight every day and yield an annual revenue of over Rs. 700 crores.

The following table gives some interesting facts about railway progress in the country :

TABLE : *Progress of All Indian Railways*
in lakhs of Rupees

Year	Kilometres	Capital at charge	Gross earnings	Working expenses	Net earnings
1947-48	54,694	74,220	18,369	16,394	1,975
1950-51	54,845	83,818	26,462	21,439	5,023
1955-56	55,902	97,591	31,751	26,017	5,734
1960-61	56,926	152,783	45,938	36,188	9,750
1961-62	57,089	169,007	50,229	39,235	10,994
1962-63	57,389	190,361	56,975	43,167	13,808
1963-64	57,585	216,649	63,384	47,474	15,910
1964-65	58,273	244,189	66,604	53,127	13,477

The following table shows the progress of railway traffic in India.

TABLE : *Railway Traffic (for all Indian Railways)*

Year	Passenger originating lakhs	Passenger earnings Rs. lakhs	Goods Originating (lakh tons)	Goods earnings (Rs. lakhs)
1950-51	13,078	9,922	930	13,977
1955-56	12,974	10,875	1,171	17,792

1960-61	16,139	13,252	1,576	28,126
1961-62	17,121	15,180	1,619	30,081
1962-63	17,770	17,018	1,801	34,340
1963-64	18,926	18,618	1,923	38,704
1964-65	20,146	20,042	1,951	39,981

India has got 58,300 kilometres of railways which operate on three gauges, (i) the broad gauge (5'$\frac{1}{8}$"); (ii) metre gauge (3'$\frac{3}{8}$"); and (iii) narrow gauge (2'6" and 2').

Before railways were taken over by the Govt. in 1944, there was a complicated system of ownership and control; some were state-owned and state-managed, a few state-owned and company-managed and others, company-owned and company-managed. The existence of a large number of big and small units was neither conducive to efficiency nor economy. Hence with a view to effecting economy and efficiency in administration a scheme for re-grouping of the entire system was prepared by the Railway Board in 1950 and enforced in 1952. By re-grouping there were 37 railway systems in India of which 9 were major, namely, (1) East Indian Rly., (2) Bengal Nagpur Rly., (3) Oudh and Tirhut Rly., (4) Assam Rly, (5) South Indian Rly., (6) Madras and South Maharatta Rly., (7) Bombay-Baroda and Central India Rly., (8) Great Indian Peninsular Rly., and (9) East Punjab Rly. All these systems have been gradually consolidated into 8 sepa rate zonal railways :

As a result of re-grouping, the following zonal divisions have been created :—

Zone	*Date of Forming*	*Former Rlys. included*	*Head quarters*	*Route Kilo meterage as on March 31, 1965*
1. Southern	April 14, 1951	M. & S. M; S. I.; and Mysore Rlys.	Madras	10152.52
2. Central	Nov. 5, 1951	G. I. P.; Nizam's State; Dholpur and Scindia Rlys.	Bombay	8873.21
3. Western	Nov. 5, 1951	B. B. & C. I.; Saurastra; Kutch; Rajasthan and Jaipur Railways.	Bombay	10068.23
4. Northern	April 14, 1952	East Punjab; Jodhpur, Bikaner the three upper Divs. of E. I. Rly. and a portion of B. B. & C. I.	Delhi	10351.40
5. Eastern	Aug. 1, 1955	E. I. Rly. (minus 3 upper Divs.)	Calcutta	4037.86
6. South Eastern	Aug. 1, 1955	B. N. Rly.	Calcutta	6354.59
7. North-Eastern	April 14, 1952	O. T. & Fatehgarh Dist. of old B. B. & C. I.	Gorakhpur	4959.82
8. North East-Frontier	Jan. 15, 1958		Pandu	3106.93

1. *Northern Railway.* It Came into being in 1952 through the amalgamation of three divisions of E. I. Rly., a portion of Bombay, Baroda and Central India Rly., and the whole of Jodhpur, Bikaner and East Punjab Rly. This line serves Punjab, Delhi, northern and eastern Rajasthan and U. P. upto Varanasi broad and meter gauge lines operate. The main broad-gauge lines are: (i) Delhi—Atari; (ii) Delhi—Ferozpore; (iii) Delhi—Kalka and (iv) Delhi—Varanasi. The meter gauge connects Delhi with Bikaner, Anupgarh and Pokhran. Its total kilometerage is 10364.17 kms.

2. *Southern Railway.* On April 14, 1951, the three railway systems—Madras and South Maharatta Rly., South Indian Rly., and Mysore Rly.—were integrated into a single railway zone serving the Madras, Mysore, Kerala and parts of Northern Maharashtra and Andhra. This railway links the northern and southern portion of India and handles grain, cotton, oilseeds, salt, sugar, tobacco, timber, hides and skin. This railway, too, has got both the gauges, meter gauge and broad gauge. Its railway kilometerage is 9938.95 kms.

The main broad gauge lines are: (i) Madras—Waltair; (ii) Madras—Raichur; (iii) Madras—Bangalore and (iv) Jalalpet—Mangalore. While the meter gauge lines are: (i) Poona—Harihar (ii) Guntakal—Masulipatam; (iii) Madras—Dhanuskodi and (iv) Madras—Trivandrum.

3. *Central Railway.* Consisting of G.I.P. Rly., Scindia, Dholpur and Nizam State Rly., serves the States of Madhya Pradesh, Maharashtra & Gujarat and north-western part of Madras. This line handles manganese, cotton and timber. It normally carries 50 million passengers and about 11 million tonnes of goods.

Its main lines are: (i) Bombay—Delhi; (ii) Bombay—Raichur; (iii) Delhi—Bezwada.

4. *Western Railway.* Comprising of B.B. and C.I. Rly. the Saurashtra, the Jaipur and Rajasthan Railways, serves Bombay, Rajasthan and Madhya Pradesh. It serves the great industrial areas of Bombay, Ahmedabad and Baroda and handles large quantities of cotton, mica and oilseeds, salt, *etc.* This line carries about 10 million tonnes of goods and 8 million passengers annually.

Its broad gauge lines are: (i) Bombay—Delhi; (ii) Bombay—Ahmedabad. While meter gauge lines are (i) Ahmedabad—Delhi; (ii) Ajmer—Khandwa. (iii) Porbandar—Dhola; (iv) Rajkot—Veraval; (v) Kandla—Bhuj and (vi) Surendranager—Okha.

5. *Eastern Railways* serve an area of 80,000 sq. miles and cover the States of West Bengal, Bihar and parts of U.P. which have a heavy population density. It is composed of five divisions of E.I. Rly.—Dinapore, Dhanbad, Ansasol, Howrah and Sealdah—all east of Moghalsarai. This railway connects the port of Calcutta with its rich vast

hinterland. It handles large quantities of rice, jute, coal, iron ore, mica and manganese.

It serves important industries like the metallurgical and steel manufacture at Burnpur and Kulti; chemical fertilizers at Sindri; Locomotives at Chitranjan. The Transport demands of the various industries like jute, chemicals, paper, engineering, cement, leather and tiles, situated around Calcutta, and at other centres is also met by this railway.

The important lines are : (1) Howrah-Moghalsarai *via* Gaya, (ii) Howrah-Moghalsaria *via* Patna and (iii) Howrah-Kiul.

6. *North Eastern Railway* has been formed with the former Oudh and Tirhut Railway and Assam Railway. It serves the northern part of West Bengal, Assam, northern part of U.P. and Northern Bihar. It carries large quantities of sugarcane, tobacco, tea and rice.

Its main lines are : (i) Gorakhpur—Amingaon; (ii) Gorakhpur—Lucknow—Kanpur; (iii) Gorakhpur—Allahabad and (iv) Pandu—Gauhati—Tinsukia. Its kilometerage is 4923.12.

7. *South Eastern Railway* connects the capital cities of three states, *viz.*, West Bengal, Orissa and Madhya Pradesh and serves an area of 185,600 sq. miles in these states as also in Andhra and Bihar, connecting the ports of Calcutta and Vishakhapatnam with their vast hinterlands, it serves the rich paddy fields of Bengal, the extensive timberlands of Orissa and M.P. as also the coal and steel industries of Bihar and Bengal. The area covered by the railway is very rich in iron ore, copper, coal, manganese, lime, bauxite and dolomite. Many of the major development projects in eastern India lie on this railway, such as Hirakud Project at Sambalpur; two new steel plants at Rourkela and Bhilai; Hindustan shipyards at Vishakhapatnam; Oil refinery at Vishakhapatnam and two steel works at Tatanager and Burnpur.

8. *North Eastern Frontier Railway.* This railway came into existence on 15th Jan. 1958. It serves the northern parts of West Bengal and Assam. The main line runs from Pandu to Tinsukhia—a distance of 520 kms. It was created out of North-Eastern Railway and has its headquarters at Pandu.

Electrification of Indian Railways

The total electrified route mileage on the Indian railways on March 31, 1960 was 330.9 miles composed of (i) Central Railway (Bombay—Kurla—Kalyan; Poona—Igatpuri and Kurla—Mantchurd)—184.85 (ii) Southern Railway (Madras—Tambaram) 18.14 (iii) Western Railway (Bombay—Borivli—Virar) 37.25 miles, (iv) Eastern Railway 88.63 miles.

In the following table the position of India is compared with some other countries :

Electrified Route

Country	Mileage	Track
U. K.	905	2,303
Japan	3,591	6,008
Germany	1,843	4,300
America	2,708	4,525
France	2,520	4,674
Italy	3,205	6,458
Sweden	3,915	5,893
Switzerland	3,008	2,565
Russia	1,040	1,565
India	240	523

The Second Plan provides for the electrification of 1,442 miles of railway lines on the following section :

Eastern Rly.—730 miles; South-Eastern Rly.—420 miles; Central Rly.—192 miles; and Southern Rly.—100 miles.

Sixty eight miles were electrified on the Eastern Railway between April 1960 and February 1961.

In order to meet the increased demand for rail transport, the Second Plan provides for the doubling of 1,607 miles of railway lines distributed thus : Eastern Rly. 43 miles; South-Eastern Rly. 605 miles; Central Rly. 214 miles; Southern railway 402 miles; Northern Rly. 151 miles; Western Rly. 163 miles and North Eastern Rly. 29 miles.

It also provides for the conversion of 265 miles from meter gauge to broad gauge on the Southern Railway. Diesel traction has been adopted on a few selected routes. A route mileage of 1,293 would also be dieselised.

ROADS

The road is the indigenous means of communication in India. Over a large part of India road building of the unmetalled type is a simple affair and presents no great difficulty. Even the metalled roads were not unknown in India as the excavations at Mohenjodaro in Sind clearly show. The road is a much cheaper means of communication than the railway, but it is not so effective and serviceable, especially the unmetalled one, as the railway. During the rainy season the unmetalled roads become impassable in most cases, and even the metalled ones are seriously handicapped when floods invade them. On such occasions the railway alone, with its high embankment and efficient maintenance service, solves effectively the problem of communication. But the rail-

way mileage is small and cannot possibly serve cheaply all the needs of a vast and poor country like India. Roads, therefore, naturally play a very important part in the country's communication.

But unfortunately the road system in India is not well developed. India's deficiency in the matter of roads has contributed very largely to the agricultural, commercial and industrial backwardness today. The most serious defect is the lack of proper and adequate road system between villages and the markets. Another aspect of inadequacy of our road system is that it is unbalanced, *e.g.*, the trunk roads are relatively more highly developed than the district and village roads. Most of the rural roads are fair weather roads. With the arrival of the Monsoon, they are turned into mud pools of dirty water and rendered unusable.

India had in 1935-36 about 3 lakh miles of roads. They gave an average of about 1½ furlong of road for every square mile of area. About a quarter of this (82 thousand miles) comprised of metalled roads. In 1951-52, India had 98,000 miles of metalled roads and about 151,000 miles of unmetalled roads. During the First Plan period, about 20,000 miles of low-type roads are expected to have been added.

The progress in road development is shown below :

Road Development

	Surfaced Roads	Unsurfaced Roads
Nagpur Plan Targets	123,000	208,000
April 1, 1951	98,000	151,000
March 31, 1956	122,000	198,000
March 31, 1957	127,000	201,000
March 31, 1961	144,000	235,000

More than half of the metalled road is in the peninsular India where the old hard rocks facilitate the building of such roads. Of the unmetalled roads, on the other hand, about four-fifth (77 p.c.) lies in the Indo-Gangetic Valley where the soft alluvium, the great distance from which the road-metal has to be obtained, and the frequent floods naturally favour the construction of the unmetalled road which is rebuilt cheaply after every rainy season. Over most of the country 40% to 75% of the areas is not being served by a road at all. The following table gives the road mileage in some States of India :

States		Metalled Roads	Unmetalled Roads
Andhra	..	16,575	8,540
Assam	..	1,646	12,352
Bihar	..	5,473	30,442

Maharashtra and Gujarat	19,659	17,596
Madhya Pradesh ..	12,470	9,242
Madras ..	16,687	9,691
Orissa ..	4,276	12,250
Punjab ..	5,042	10,096
Uttar Pradesh ..	11,935	35,200
West Bengal ..	6,058	18,072
Jammu and Kashmir	966	1,213
Mysore ..	14,179	8,991
Rajasthan ..	6,958	19,979
Kerala ..	4,939	4,861

How poor is our road system compared to western countries is seen from the following table :

Country	Road mileage Per one Lakh Persons.	Road mileage per Sq. mile.
Italy	376	0.89
U. K.	381	2.02
France	934	1.84
W. Germany ..	260	0.95
U. S. A. ..	2,411	1.03
Japan	728	3.0
India	73	0.22

It will thus be seen that total mileage of roads in India is far short of her requirements. India has 20.1 miles of roads per 100 sq. miles. The comparable figure for U.S.A., U.K., and Japan are 100, 200, 400 miles respectively.

The total number of motor vehicles on the road during 1960 was estimated to be 5,98,384 as compared to 294,727 in 1951-52. This number must be considered very small, having regard to the size of the country, its road mileage and its population. The total number of automobiles was composed of the following :

Motor cycles	69364
Auto-Rickshaws	4960
Jeeps	26290
Private Cars	240370
Public service vehicles	50767

Motor cabs	18148
Goods vehicles	152938
Miscellaneous vehicles	35547

Privately owned automobile is the most widely used means of transport in U.S.A., U.K., France and Canada. Every third person in U.S.A., every fifteenth in U.K., every sixteenth in France and every eighth in Canada has an automobile, whereas there is only one vehicle for 1,350 persons in India. Road transport is so elaborately developed in those countries that it is possible to reach almost every town or village by a motor bus.

Nagpur Plan

A Ten-Year Plan for road development known as the 'Nagpur Plan' was drawn up in 1944 for an increase of road mileage from 265,000 to 4,000,000. The Plan visualised the growth of a network of road communications at a cost of Rs. 372 crores within 10 years. The programme had to be curtailed owing to shortage of money, material and trained personnel. The Nagpur Plan recommended the classification of roads according to their functions. Thus, roads were divided into : (i) National Highways; (ii) State Highways; (iii) District Roads; and (iv) Village Roads. (i) The *National Highways* are to be frameworked for the country's road system. These will connect capitals of states, ports and highways. They also include roads of strategic importance. (ii) The *State highways* are the main trunk roads of the state. (iii) The *District Roads* connect areas of production and markets with either a highway or a railway. They also form the link between headquarters of neighbouring districts. (iv) The *Village Roads* mostly meet the requirements of rural population, they connect villages and group of villages with one another and with nearest district road or river ghat.

The National Highways are "main Highways serving predominantly national, as distinct, from state purposes, running through the length and breadth of India, which togethr form a system connecting (by routes as direct as practicable) major ports, foreign highways, capitals of states and including highways required for strategic movements for the defence of India."

The *National Highways* include *Grand Trunk* Road from (i) Calcutta to Amritsar; (ii) Agra-Bombay Road; (iii) Bombay-Bangalore-Madras Road; (iv) Madras-Calcutta Road ; (v) Calcutta-Nagpur-Bombay Road; (vi) Varanasi-Nagpur-Hyderabad-Kurnool-Bangalore-Cape Comorin Road; (vii) Delhi-Ahmedabad-Bombay Road; (viii) Road from Ahmedabad to Kandla Port with a branch road to Porbandar; (ix) Hindustan-Tibet Road from Ambala to Tibet *via* Simla; (x) Delhi-Lucknow Road; (xi) Assam Access Road—Assam Trunk Road on the Sixth Bank of Brahmaputra and road branching off from the Assam Trunk Road towards Burma border through Manipur state.

The national highway mileage in India is 24,020 kilometres, distributed as below :

Andhra	2272 Kilometres	Madras	1690 Kilometres
Assam	1347 ,,	Maharashtra	2393 ,,
Bihar	1878 ,,	Mysore	1313 ,,
Gujarat	1088 ,,	Orissa	1371 ,,
Jammu and Kashmir	544 ,,	Punjab	1262 ,,
Kerala	418 ,,	Rajasthan	1259 ,,
M. P.	2686 ,,	U. P.	2341 ,,
Delhi	72 ,,	W. Bengal	1439 ,,
Himachal Pradesh	322 ,,	Manipur	212 ,,
		Nagaland	111 ,,

The roads declared as national highways under the National Highways Act 1956, are shown below. Figures in brackets represent the length of the highway in kilometres.

Serial No.	National Highway No.	Description of National Highway
1.	1	Connecting Delhi, Ambala, Jullundur and Amritsar and proceeding to the border between India and Pakistan (454).
2.	1A	Connecting Jullundur, Madhopur, Jammu, Banihal, Srinagar, Baramula and Uri (666).
3.	2	Connecting Delhi, Mathura, Agra, Kanpur, Allahabad, Varanasi, Mohania, Barhi and Calcutta (1,503).
4.	3	Connecting Agra, Gwalior, Shivpuri, Indore, Dhulia, Nasik, Thana and Bombay (1,167).
5.	4	Starting from its junction near Thana with the highway specified is serial No. 4 and connecting Poona, Belgaum, Hubli, Bangalore, Ranipet and Madras (1170).
6.	5	Starting from its junction near Baharagora with the highway specified in serial No. 7 and connecting Cuttack, Bhubaneswar, Vishkhapatnam, Vijayawada, and Madras (1,502).
7.	6	Starting from its junction near Dhulia with the highway specified is serial No. 4 and connecting Nagpur, Raipur, Sambalpur, Baharagora and Calcutta (1,654).

8.	7	Starting from its junction near Varanasi with the highway specified in serial No. 3 and connecting Mangawan, Rewa, Jabalpur, Lakhnadon, Nagpur, Hyderabad, Kurnool, Bangalore, Krishnagiri, Salem, Dindigul, Madurai and Kanyakumari (2372).
9.	8	Connecting Delhi, Jaipur, Ajmer, Udaipur, Ahmedabad, Baroda and Bombay (1436).
10.	8A	Connecting Ahmedabad, Limbdi, Morvi, and Kandla (380).
11.	8B	Starting from its junction near Bamanbore with the highway specified in serial No. 10 and connecting Rajkot and Porbandar (208).
12.	9	Connecting Poona, Sholapur, Hyderabad and Vijayawada (801).
13.	10	Connecting Delhi and Fazilka and proceeding to the border between India and Pakistan (406).
13A	11	Connecting Agra, Jaipur and Bikaner (586).
13B	12	Connecting Jabalpur, Bhopal and Biaora (426).
13C	13	Connecting Sholapur and Chitraldrug (494).
14.	22	Connecting Ambala, Kalka, Simla, Narkanda, Rampur and Chini and proceeding to the border between India and Tibet near Shipki-La (462).
15.	24	Connecting Delhi, Bareilly and Lucknow (441).
16.	25	Connecting Lucknow, Kanpur, Jhansi and Shivpuri (320).
17.	26	Connecting Jhansi and Lakhnadon (399).
18.	27	Connecting Allahabad with the highway specified in serial No. 8 near Mangawan (95).
19.	28	Starting from its junction near Barauni with highway specified in serial No. 23 and connecting Muzaffarpur, Pipra, Gorakhpur and Lucknow (573).
20.	28A	Starting from its junction near Pipra with the highway specified in serial No. 19 and connecting Sagauli and Raxaul and proceeding to the border between India and Nepal (68).
21.	29	Connecting Gorakhpur, Ghazipur and Varanasi (198).
22.	30	Starting from its junction near Mohania with the highway specified in serial No. 3 and connecting Patna and Bakhtiyarpur (232).

23.	31	Starting from its junction near Barhi with the highway specified in serial No. 3 and connecting Bakhtiyarpur, Mokameh, Purnea, Palkhola, Siliguri, Sivok and Cooch Behar and proceeding to its junction with the highway specified in serial No. 28 near Pandu (958).
24.	31A	Connecting Sivok and Gangtok (93).
24A	31A	Starting from North Salmara to its junction with N.H. No. 37 near Goalpara (177).
24AA	32	Starting from its junction near Govindpur with N.H. No. (2180).
25.	33	Starting from its junction near Barhi with the highway specified in serial No. 3 and connecting Ranchi and Tatanagar and proceeding to its junction with the highway specified in serial No. 7 near Baharagora (354).
26.	34	Starting from its junction near Dalkhola with the highway specified in serial No. 23 and connecting Berhampore, Barasat and Calcutta (446).
27.	35	Connecting Barasat and Bangaon and proceeding to the border between India and Pakistan (61).
28.	37	Starting from its junction near Goalpara with the highway specified in serial No. 23 and connecing Gauhati, Jorhat, Kamargaon, Makum and Saikoha Ghat (703).
29.	38	Connecting Makum, Ledo and Lekhapani (55).
30.	39	Connecting Kamargaon, Imphal and Palel and proceeding to the border between India and Burma (441).
31.	40	Connecting Jorhat and Shillong and proceeding to the border between India and Pakistan near Dawki (161).
32.	42	Starting from its junction near Sambalpur with the highway specified in serial No. 7 and proceeding *via* Angul to its junction with the highway specified in serial No. 6 near Cuttack (262).
33.	43	Connecting Raipur and Vizianagram and proceeding to its junction with the highway specified in serial No. 6 near Vizianagaram (560).
34.	45	Connecting Madras, Tiruchirapalli and Dindigul (389).

35.	46	Connecting Krishnagiri and Raniput (132).
36.	47	Connecting Salem, Coimbatore, Trichur, Ernakulam, Trivandrum and Kanyakumari (665).
37.	47A	Starting from its junction near Trichur with the highway specified in serial No. 36 and connecting with the West Coast Road near Chaliseri (29).
38.	49	Connecting Madurai and Dhanushkoti (145).
39.	50	Connecting Nasik with the highway specified in serial No. 5 near Poona (193).

WATER TRANSPORT

From ancient times, the trade and commerce of Northern India has been facilitated by the abundance of navigable streams and the flat topography of the countries. History records evidence of a flourishing trade carried on along the rivers and canals of India from the earliest times. The importance of waterways gradually diminished with the development of the railways with the result that the steamer service was gradually withdrawn and country boat traffic also decreased, so that new inland water transport is of minor importance. Its goods traffic being only 1% of that of the railways in terms of ton-volumeters. The steamer traffic on inland waterways at present carries an estimated volume of $2\frac{1}{2}$ million tons traffic only.

India is a land of many rivers, and yet water transport has not made much headway in this country. There are certain geographical drawbacks under which water transport has to labour in India. (i) During the rainy season the rivers are in high floods and consequently have a strong current which is not easy to navigate. During dry seasons, on the other hand, only the big rivers have water throughout their course, others become disconnected pools in which *navigation* is impossible.

(ii) Even in the big rivers the water is very shallow and there are sandbars due to silting which further reduce the depth of the water. There is a considerable distance of the dry bed of the river which must be crossed before coming to the water. Owing to the sandy nature of this bed vehicular traffic is almost impossible there. Over a large part of the country, thus, the towns on the river banks cannot make use of the river transport fully. Owing to the shifting rivers' course, it is not possible to make any permanent jetty or wharf on these rivers. The multipurpose schemes under construction in certain parts of India may improve the navigability of some rivers.

(iii) Indian rivers usually enter the sea in shallow, sandy delta-mouths, instead of broad and deep estuaries, which in western countries, offer a pathway for ships far into the interior.

(iv) The upper reaches of the rivers have been used for irrigation purposes and this hardly leaves any water for navigation for hundreds of miles below.

The mileage of water-ways in India is estimated to be about 88,000 kilometres. Of these about 41,600 kilometres are rivers and 24,640 kms. canals. U. P. has 184 kilometres of navigable waterways, Bihar 1144 kilometers. Bengal 1224 kilometers, Assam 1472 kilometers, Orissa 450 kilometers and Madras 2720 kilomters. Thus inland water transport is mainly confined to the States of Assam, West Bengal, Orissa, Bihar, U. P., Madras, Andhra and Kerala.

The total length block of waterways affording perennial navigation to steamers and country boats with drafts of 2 ft. to 6 ft. is estimated to be 9,200 kilometers. Of this total 4,800 kilometers represent navigable rivers and the rest the canals and back waters of the Malabar coast. The navigable portions are 1920 of the Ganga river system, 1472 kms. of the Brahmaputra river system, 240 kilometers of the Hooghly river, 320 kilometers of the other rivers in West Bengal, 244 kilometers of Mahanadi, Brahamni and Baitarani rivers of Orissa, 460 kilometers of Godawari river and 52 miles of the Krishna river. Of this total about 2400 kilometres of Ganga-Brahmaputra river systems are navigable by steamers and the rest by country boats also.

In Lower Bengal, Assam and in the river deltas on the east coast, however, there is enough water in the rivers and navigation is possible throughout the year. These regions are not well supplied with railways or roads. This fact naturally makes navigation the only efficient means of communication. On the Ganga in Bengal and Bihar and on the Brahmaputra in Assam a large number of steamers, apart from the samll country boats, ply to cope with the large amount of traffic that is diverted to the rivers. The size of these steamers is limited by the minimum depth available during the dry season. For about 800 kilometers from its mouth, Ganga maintains a nearly uniform depth of about 15 metres and so steamers can safely move upto the distance, although country boats proceed as far as Hardwar. Ocean-going steamers come upto Calcutta on the Hooghly with the help of continuous dredging. The current in the Ganga becomes sluggish in Bengal owing to the low height above sea level. The rivers therefore, deposit sit with considerable speed. Dredging has to be very active to keep the traffic channel in the river open.

The Brahmaputra is navigable by steamers throughout the year and steamers run from the mouth to Dibrugarh. It carries Assam oil, tea, timber and jute which are brought to Calcutta by having them transferred to road and rail system on the border of Pakistan. Navigation is rendered difficult in this river because of the formation of new islands, sand banks and shoals, and the presence of a very strong current during the rains. Steamer traffic on the Ganga and Brahmaputra is

of the order of 625 million ton-miles a year. Country boat traffic on these rivers is nearly twice as much.

Though a number of rivers are found in Deccan yet owing to their rock surface, they are navigable only in their lower courses and that too during the rainy season, when there is enough water in them. Narbada, Tapti, Mahanadi, Krishna and Kauvery are such rivers.

The majority of the earlier irrigation canals were designed to combine navigation with their primary function of irrigation. In the absence of serious railway competition in those days high hopes were held of the possibilities of utilizing these arterial waterways for navigation also. Communications were, at the time, both inferior and inadequate, and the new canals, passing as they did through fertile and populous country, appeared to offer a good opportunity for their improvement.

It is now realised, however, that the combination of irrigation and navigation cannot, unless the circumstances are very special, be successfully effected. There are various reasons for this. A canal designed primarily for irrigation must be aligned so as to afford command of a maximum area of cultivable land, without reference to the position of trade centres. The traffic attracted is consequently very limited. Moreover, in a highly cultivated tract large number of cattle are required for ploughing. These cattle are available for carting the surplus crops to market at nominal cost to the owners. This fact, therefore, militates against the extensive use of canals for carrying foodgrains. The Ganga Canal, which is navigable throughout its length and passes through one of the richest plains in India, fails to recover in tolls from the boats even the small extra cost of maintaining navigation upon it.

Some of the irrigation canals also allow small boats to ply. The delta canals on the east coast are the most important for this; though some goods traffic passes on the Ganga canals also. Some of the irrigation canals in the Punjab allow timber logs to be transported in rafts. The Sone canals also play an important part in navigation. They carry generally low grade cargo mostly, sand, clay and stone, *etc.*, from the Kaimur hills.

Navigation canals are even less important than the rivers. The total mileage of navigation canals and back-waters in India is about 2,750; more than two-thirds being in Bengal and Madras. In the coastal districts of Bengal where no other means of transport is possible, canals are easy to build. The large number of hills or depressions full of water are easily inter-connected to provide a canal for navigation and for draining the land. Bengal has, therefore, largest navigation canals mileage in India.

The Buckingham Canal (on the east coast in Andhra, Madras), and the Orissa Coast Canal both let in sea water to provide sufficient depth for boats. These two are t he largest navigation canals in India.

The two most important navigable systems of irrigation works are the Godavari and the Krishna delta canals in Madras—which are 156 kms. and 672 kilometres long respectively. There are particularly strong reasons for using these canals for navigation. During many months in the year they carry away all, or nearly all the river water supply, and so cut off the upper waters of the rivers from the seaboard. They traverse flat and fully cultivated deltas in which there are no great falls to be overcome. These deltas are, besides, ill-provided with roads and other means of communication. The lower ends of the canals are connected by the sea; the head of each system is connected with that of the other. Thus, the upper waters of the Godavari and of the Krishna are connected with the Buckingham Canal. The facilities provided are, in such circumstances, a great boon to the cultivators. Yet even here it cannot be said that navigation is directly remunerative.

The four canals, the Kurnool-Cuddapah canal (73 miles); the Orissa canal (170 miles); the Midnapore canal (287 miles) and the Sone canal (204 miles) are all navigable; indeed their primary object was navigation, but they are not a success.

The Buckingham Canal (258 miles) in Madras is a purely navigation canal. It runs parallel and close to the coast, joining up a succession of backwaters of the sea. It extends for 196 miles north and 66 miles south of Madras town. It joins with the Connanur canal of the Krishna Delta system.

The canal was open alike to river floods and to tidal flow and had no regulating works in the beginning. Heavy silting naturally occurred in the channel and traffic was greatly impeded under these circumstances. Experience also showed that the alignment had been taken far too near the sea and was consequently subject to damage from high tides and storm waves. Accordingly, remodelling was undertaken in 1883. The canal was realigned in parts so as to take it out of back-waters and further from the sea. An embankment, to protect it from waves, was also constructed along its eastern side. Floodgates were fitted across the channel where it entered and left the various back-waters and rivers which it crossed in its course. This was done to shut floods out of the canal. After 1893, most of these flood gates were replaced by a series of locks designed to retain a surface water level in the canal approximately upto the level of the highest prevailing tides.

Through traffic from the Godavari and the Krishna deltas to Madras has now disappeared on this canal, owing to the building of the Calcutta-Madras Railway, which runs parallel and close to the Buckingham Canal. The canal is now principally used for the transport of salt and firewood into Madras city from short distances south.

From the above description it would be clear that out inland water transport is not fully developed. The following table gives the figures for inland waterways in some important countries of the world.

Length of Waterways

Country	Total Length	Length per 10,000 sq. miles of land	Length per 1,000 per-tons
Netherlands	4,340	340.7	4.5
Belgium	1,054	91.0	1.25
Czechoslovakia	1,860	34.4	1.5
France	5,950	28.0	1.43
England	2,400	25.5	0.48
Germany	3,900	21.5	0.6
Poland	2,730	18.2	1.14
U. S. A.	28,000	9.8	1.95
Egypt	2,081	5.4	1.09
India	5,257	3.2	0.15

Hence, it becomes necessary to develop our inland water transport. A planned and co-ordinated development of cheap water transport is one of the principal solutions for meeting the increased traffic. Both in the interest of long-range development and the over-all economy of the country, water-transport deserves every consideration. Waterways and railways should be supplementary to each other because there is a natural division of traffic between the two. "To the rail road goes the least burdensome traffic, which demands regularity and quick transit; to the waterways gravitate the heavy freights of small value, which can only be transported when freights are low." The development of water transport will not only remove the congestion of traffic from railways, but would also open up many new areas whose products cannot be at present moved because of high railway freights.

Fortunately the responsibility of further surveys, planning and development of waterways has been assigned to the Central Water and Power Commission, which has drawn up a master plan for developing inland waterways in the country. This envisages (i) the linking of Calcutta port on the east with Cochin in the west *via* Cuttack and Madras by a network of canals connecting some of the minor rivers of Orissa, Andhra, and Madras, (ii) a continuous waterway from Western India to northern and north-east India *via* Central India and a continuous waterway from the west coast to east coast through the hinterlands of Bombay, Madhya Pradesh and Andhra Pradesh.

The Ganga-Brahmaputra Water Transport Board (1952) has been let by the Government with the responsibility of improving the Ganga-Brahmaputra river systems for navigation and to extend it as far

as possible. This Board will co-ordinate and stimulate the navigational activities of the states of U.P., Bihar, Assam and West Bengal situated on this river system. Under this Board, plans are now afoot for starting a pilot project with up-to-date craft for towing barges on the shallow stretches of Upper Ganga between Patna and Allahabad.

The new multi-purpose projects include the following schemes for navigation channels :

1. U. P.

(i) Resuscitation of the Goghra river up to Barhamghat to extend navigational facilities.

(ii) Ravival of navigation of the Ganga upto Allahabad and the development of navigation in the Yamuna River upto Etawah.

(iii) The flood control on Betwa and Chambal to provide an ample discharge in the Yamuna during the dry season which may permit navigation on the Yamuna.

2. West Bengal

(i) The construction of a navigation Canal from Durgapur to Hooghly under the D. V. C., to connect the coalfields of West Bengal and Bihar with the port of Calcutta.

(ii) Resuscitation of the Bhagirathi route affording direct and shorter connection with Calcutta port by the construction of a Barrage on the Ganga (which is still under the consideration of the Central Govt.). The objectives of this barrage are : (i) construction of the Barrage across the Ganga in the border of Bengal-Bihar; (ii) the provision of a greater volume of water in the Bhagirathi and other rivers of West Bengal; (iii) the navigable route between Calcutta and the Ganga; and (iv) conservation of the river Hooghly for the benefit of Calcutta by bringing down sufficient head water.

With the completion of this project, the Bhagirathi will become navigable throughout the year, and the salinity of the river Hooghly will also be reduced by the continuous flow of water of the Bhagirathi.

3. Assam

Resuscitation of the various tributaries of Brahmaputra—Dihing, Dibu, Dhansiri and Kalung—in the upper Assam Valley.

4. Orissa

(i) The Mahanadi Valley Project provides for navigation on the Mahanadi River in Orissa upto 200 miles from the sea and connecting the hinterland with Pradip—10 miles up the Mahanadi from its fall into the sea.

(ii) The Orissa Coastal Canal together with an extension of the Mahanadi Delta system, thereby affording direct inland navigation from Assam to Madras.

5. Bihar

(i) Resuscitation of the Ganda and Kosi rivers and their tributaries.

(ii) Extension of navigation in the Sone river for about 150 miles as visualised in the Sone River Project.

6. Madhya Pradesh

The Narbada and Tapti multi-purpose projects including navigation are under consideration of the Govt.

7. Bombay

Kakrapar Project in the state will provide navigational facilities from the sea to Kakrapar Dam and 50 miles further land.

8. Madras and Andhra

The proposed works on the Godavari, the Krishna, the Pranbita and the Wain Ganga will provide navigation facilities.

SHIPPING

India has about 3,500 miles of coast line but her shipping industry is insignificant when compared to those of great maritime powers. Indian shipping having 9.05 lakh gross registered tonnage is about 0.52% of the world tonnage. It is adequate to carry the entire coastal, about 40% of the adjacent and about 5% of the overseas trade. Her coastal vessels carry about 2 million passengers a year, while about 200,000 overseas passengers travel by Indian ships.

The Shipping Policy Committee of 1947 laid down the following objectives for Indian shipping with a view to secure 2 million tons in near future, thereby securing the Indian shipping—(1) 100 per cent of the coastal trade of India, (2) 75% of India's trade with Burma, Ceylon and other neighbouring countries, (3) 50% of India's overseas trade and (4) 30% of the Orient's trade. The First Plan envisaged a rise in India's shipping tonnage from 390,707 GRT to 600,000 GRT by 1956. In the Second Plan, 3000,000 GRT are expected to be added so that the total tonnage would be 900,000 GRT by 1960-61. With the achievement of this target Indian tonnage is expected to carry about 12 to 15% of the country's overseas trade; 50% of her trade with adjacent countries as against the present proportions respectivel of 5 and 40 per cent.

The Central Govt. have taken the following steps to encourage the development of Indian shipping :

1. Reservation of coastal traffic for Indian ships only since 1950. The aggregate quantity of cargo in dead weight tonnes carried on the coast was 24.49 lakhs in 1951 and 28.49 lakhs in 1954. While all coastal cargo is now carried by Indian ships, the Government have also negotiated with foreign shipping interest and ensured for Indian Shipping a fair share of the trades with Burma, Ceylon and Pakistan.

2. The Government also grants loans for the purchase of necessary shipping requisites, *e.g.*, the private sector has received loans to the extent of Rs. 24 crores during 1951-56, and Rs. 12.5 crores for 1956-61 for adding to their fleet. 37 ships (totalling about 68,000 GRT) will be added under this aid.

3. Sale of ships built at the Hindustan Shipyard at the U. K. parity prices.

4. Allotment of Government owned and—or controlled Cargo.

5. Sponsoring admission to Industrial Conferences.

6. Establishment of two State Shipping Corporations. The Eastern Shipping Corporation was set up in 1950. It owns 8 vessels totalling 42,293 GRT and has regular services to Australia, East Africa, Malaya and Japan and passenger *cum* cargo service on the India-Singapur and ndia-East Africa routes. It also runs the India-Andaman service. The Western Shipping Corporation was set up in 1956 and it functions along the Indian-Persian Gulf, India-Red Sea, India-Poland and India-Russian routes.

Overseas Shipping

It is estimated that Indian Liner Companies between themselves do not carry more than 5 per cent of the overseas trade. The total tonnage employed by Indian Cos. in the foreign trade is about 371,763 GRT. The five Indian Cos. are now operating in foreign trades and their total gross tonnages are :

(1) Scindias—197,288 G. R. T.

(2) Indian Steamship—73,293 G. R. T.

(3) Bharat Lines—64,849 G. R. T.

(4) Great Eastern Shipping—38,167 G. R. T.

(5) Western Shipping Corporation Ltd.

(6) Jayanti Shipping Corporation.

Though the Indian Government has endorsed the policy of Indian shipping carrying at least of 50% of India's trade in international waters, there are a number of handicaps which Indian shipping will have to cross for carrying this much Indian overseas trade.

(i) A large number of Liner Conferences dominate these trades. Entry into such Conferences is not an easy matter. Indian Lines have

not yet been admitted to membership of a number of conferences in the waytrades on the main trade routes between India and U.K. and India and the Continent such as Colombo—U.K.; U.K.—Colombo; Colombo—Continent; U. K.—Aden and U.K.—Port Said Conference.

(ii) Indian Shipping Cos. will have to expand their tonnage on different lines where they do not go at present.

(iii) The Passenger services should be opened with modern amenities.

At the end of November 1961, 175 ships totalling 9.05 lakh GRT were on the Indian Register—100 ships of 3.43 lakh GRT on the coastal trade and 75 vessels of 5.62 lakh GRT on the overseas trade. Indian vessels ply on six overseas routes, as said above. On four of the six routes, the ships carry cargo and on the two cargo as well as passengers.

AIR TRANSPORT

Air transport is the least important of the means of communication in India at present. India has a strategic position on the Air route to Australia. The main lines between Europe and Australia have to pass through India.

There are in the Indian Republic 84 airports; of these Dum Dum (Calcutta) is the biggest airport in Asia. Airports of Calcutta, Bombay and Delhi are on the International Air Routes. The airports are a few miles away from the main cities; *e.g.*, the airports of Delhi are at Palam and at Safdarjang; of Calcutta at Dum Dum and Barrackpore; of Bombay at Santa Cruz and Juhu; of Madras at St. Thomas Mount; of Allahabad at Bamrauli, and so on.

Delhi, Bombay, Calcutta, Madras, Tiruchirapalli, Vishakhapatnam, Agartala, Ahmedabad, Patna, Bhuj, Jodhpur and Amritsar are the customs airports where taxes are paid on imported goods by the passengers.

Six new aerodromes at Haldwani (U.P.), Kandla, Tulihal (Manipur), Raxaul (Bihar), Jogbani (Bihar) and Behala (Bengal) have been completed.

Besides the airports, there are a number of airstrips for landing and take off of the planes. The Government of India is spending about half a crore of rupees every year on these airports and strips.

Indian aircrafts flew about 290 lakh miles carrying about 8 lakh passengers and nearly 1,942 lakh pounds of cargo and mail on scheduled services and non-scheduled services taken together during 1958.

During 1961 (estimated) Indian aircraft flew about 331 lakh miles carrying about 10.6 lakh passengers and nearly 1822 lakh pounds of cargo and mail on scheduled services and non-scheduled services taken together.

The scheduled air transport services flew 27,452,000 miles in 1961 as against 24,742,000 miles in 1959. The number of passengers and freight carried increased from 736000 and 73877000 lbs. respectively in 1959 to 948000 passengers and 88359000 lbs. of freight in 1961. The mail carried by scheduled services showed remarkable increase in 1959 at first that of 1958, and after a slight decrease in 1960 there was further increase in 1961. In 1958 the mail carried by scheduled services was 13608000 lbs.; in 1959 15049000 lbs.; in 1960, 15029000 lbs. and in 1961—1622800 lbs.

During 1959 nearly 5578000 miles were flown on non-scheduled operations against 1958 figure of 4997000 miles. In 1960, 6161000 miles were flown but in 1961 only 56,57000 miles showing decrease. The number of passengers and cargo carried were approximately 89000 and 81142000 lbs. respectively in 1959; and 88000 and 85784000 lbs. respectively in 1960. For 1961 the estimated figures were 111000 passengers carried and 77585000 lbs. freight carried.

The introduction by Air-India International of a weekly scheduled service in each direct.on between Delhi and Moscow, *via* Tashkent, was an important development in the field of international air transport services. A scheduled weekly cargo service between India and U.K. has been introduced. A scheduled halt at Djakarta was provided on the service operated between Bombay and Sydney and the frequency of the Bombay-Tokyo service was increased from two to three times a week.

The progress of air transport in India is shown by the following table :

Year	Miles flown	Passengers carried	Freight carried (lbs.)
1947	13,413,000	287,000	8,641,000
1951	26,112,000	515,000	219,289,000
1956	29,216,000	673,000	193,320,000
1957	28,054,000	741,000	174,394,000
1958	29,575,000	795,000	177,841,000
1959	30,320,000	825,000	150,019,000
1960	30,933,000	921,000	153,858,000
1961	33,100,000	1060,000	182,200,000

Since 1947, the passenger traffic has more than doubled, the cargo loads have gone up more than 17 times, mail loads about 9 times and m les flown about 2½ times.

Airways in India depend for their success largely upon the small load that they carry.' It will, therefore, be right to give the story in brief of the improvement and development of air mail in India.

In April, 1929, was started the first regular Air Mail Service from India. A direct air mail service was established between England and India, and mails for most of the countries in Europe and for Iraq, Palestine, Egypt and Persia were sent by this service. The Indian state service, a state-owned air mail line, was established in December, 1929, between Delhi and Karachi to connect with the Imperial Airways Service between India and England. This service was operated by the Delhi Flying Club from January, 1932.

In 1930, the Royal Dutch Air Company established a fortnightly service between Holland and the Dutch East Indies across India. A French Air Company also began to operate in the same year, the Marseilles-Saigon Air Services across India. These services dropped mails for India at the frontier posts of entry and were not allowed to carry internal India traffic. In 1932, however, it was decided to use both services for the carriage of Indian foreign mails to places which were not served by the British air services.

An air parcel service was introduced between Great Britain and Northern Ireland and India in May, 1931, and in July an air mail postcard service was also introduced. An air mail postcard, first of its kind in the whole world, was put on sale to the public, bearing a stamp and a blue air mail label printed thereon.

In January, 1932, the Cairo-Mwaza Air Mail Service of Imperial Airways was extended to South Africa and the first despatch of the air from India for South Africa was made form Karachi on 20th January, 1932.

A feeder service was started in 1932 between Karachi, Bombay and Madras connecting at Karachi with the London-Karachi service. This was made possible through the enterprise of the Tatas Limited under a ten-year contract with the Government of India. The internal service between Delhi and Karachi maintained by the Delhi Flying Club ceased to operate from 4th July, 1933. A new Company, called the Indian Trans-Continental Airways Limited, working in conjunction with the Imperial Airways Limited started from 7th July, a weekly air mail service between Karachi and Calcutta. The service was extended to Rangoon *via* Akyab from 1st October, 1933, and to Singapore from 15th December, 1933.

The Indian National Airways Limited introduced from 1st December, 1933 a daily mail and passenger service between Calcutta and Dacca and a weekly serivce between Calcutta and Rangoon. The Madras Air Tax Service started from 10th February, 1934, a bi-weekly air mail service between Madras and Calcutta. Later on, however, these

services ceased to operate. A new weekly air mail service was started from December, 1934, between Karachi and Lahore, the service being operated by the Indian National Airways Limited. This service was later duplicated.

In 1935 increased facilities for the transmission of correspondence were provided. The service between Calcutta and Singapore was duplicated and operated jointly by Imperial Airways and Indian-Continental Airways. A connection was established at Athens between the westbound places from Karachi and the northbound places of the Greece-Germany Air Service. Use began to be made of the air service operated by Imperial Airways betwen Khartoum and Kano (Nigeria) for the despatch of air mail to West Africa. A new weekly air service was established towards the end of 1935 by Tata Sons Limited for operation during May between Bombay and Trivandrum.

Since 1935 air mail correspondence for places in the United States began to be accepted for despatch by the internal air service in that country. Correspondence for South America also was accepted for transmission by air *via* Germany or France.

In 1936 the service between Singapore and Australia was duplicated, the Khartoum-Kano weekly service was extended to Lagos and a weekly air mail service was introduced between Penang and Hong Kong.

Another internal air service was opened between Bombay and Delhi in November, 1937, and yet another from Bombay to Kathiawar in November, 1938. Simultaneously with the introduction of this scheme, the frequency with the internal feeder services, namely, Karachi-Madras and Karachi-Lahore was increased first to four and then to five times a week. Karachi-Madras service was extended to Ceylon and Bombay Trivandrum service to Trichinopoly to connect with the Karachi-Colombo service.

After partition, the Air Communication in India was re-organised. Delhi was now connected to Bombay from where planes took off for Europe. The foreign companies still make use of Karachi for this purpose.

From June 1, 1951 the Deccan Airways, recently taken over by the Government of India, commenced operating the Night Air Mail service when their first Nagpur-bound planes took off from the Dum Dum airport with about 100 bags of mail and 13 passengers.

From August 1, 1953, the Government nationalised all air transport in India. All the eight companies for inland operation were formed into the Indian Air Lines Corporation. Those working in the international air transport were organised into the Air-India International Corporation. The advantages of nationalisation can briefly be listed as follows :

(1) The available resources in equipment, workshop capacity and technical personnel would be used to the maximum benefit.

(2) From the point of view of defence, operation of all air services by a state organisation would obviously be the most desirable arrangement.

(3) Air transport is a public utility and ought to be developed to serve national interests.

(4) Rapid developments are taking place in the techniques of civil aviation and only a state organisation can command the resources to take the fullest advantage of these technical developments.

The two Corporations Indian Air Lines Corporations and Air India International came into existence on 15th June, 1953. The Air India International took over the business of the Air-India International Ltd., while Indian Airlines Corporation took over as a going concern, the assets, liabilities and business of eight units, namely, Airways (India) Ltd., Himalayan Aviation Ltd., Kalinga Airlines, Bharat Airways Ltd., Air-India Ltd. Air Services of India Ltd., Deccan Airways Ltd., and Indian National Airways.

Indian Airlines Routes

Frequent air services are available along the two coasts.

(i) From Colombo through Madras—Vishakhapatnam—Bhubneshwar to Calcutta in the east; and from Trivandrum through Cochin—Mangalore Bombay to Jamnagar. Bhuj on the west coast.

(ii) Through the interior : linking Madras and Bombay with Bangalore, Hyderabad and Poona; Bombay and Calcutta with Varanasi, Lucknow and Nagpur.

(iii) In the far north from Delhi to Srinagar.

(iv) In the east between Calcutta and Imphal and other parts in Assam.

Other Indian Airline routes bring country's nearest neighbours within a few hour's flight, as between Delhi and Karachi *via* Jaipur and Jodhpur, Delhi and Lahore; Calcutta and Dacca—Chittagong; Patna—Kathmandu in Nepal. Another 'neighbour' service links Kandahar and Kabul in Afghanistan with Karachi and Delhi or Bombay.

The Indian Airlines Corporation with its fleet of 97 aircrafts links up most of the principal centres in the country, and its air routes cover a total mileage of 22,700. Its aircraft carried 599,573 passengers and flew a total of 183,18,552 miles during 1957-58. The services of Indian Air Lines Corporation units radiate from important centres like Madras, Bombay, Calcutta, Agartala, Delhi and Srinagar. The important air routes are :

A. *Madras* (1) Madras—Trivandrum—Madras. (2) Madras—Hyderabad—Nagpur—Delhi. (3) Madras—Nagpur—Delhi (Night air mail service).

B. *Bombay* (1) Bombay—Poona—Hyderabad—Bangalore; (2) Bombay—Nagpur—Calcutta (Night air mail service); (3) Bombay—Karachi—Bombay ; (4) Bombay—Ahmedabad—Bhuj—Karachi ; (5) Bombay—Bhavnagar—Rajkot—Jamnagar—Bhuj; (6) Bombay—Keshod—Porbandar—Jamnagar; (7) Bombay—Belgaum—Mangalore—Chochin; (8) Bombay—Calcutta—Bombay; (9) Bombay—Colombo—Bombay and (10) Bombay—Delhi—Bombay.

C. *Calcutta* (1) Calcutta—Gauhati—Tejpur—Jorhat—Mohanbari; (2) Calcutta-Gauhati—Jorhat—Lilabari—Jorhat — Passighat; (3) Calcutta——Agartala—Gauhati—Silchar; (4) Calcutta—Agartala, Gauhati—Khavai—Kamalpur — Kailashahar — Silchar—Imphal; (5) Calcutta—Bangalore—Calcutta; (6) Calcutta—Dacca—Calcutta; (7) Calcutta—Chittagong—Calcutta; (8) Calcutta—Rangoon—Calcutta; (9) Calcutta—Bagdogre—Calcutta.

D. *Delhi* (1) Delhi-Calcutta—Delhi; (2) Delhi—Lucknow—Gorakhpur—Varanasi — Patna — Calcutta; (3) Delhi — Srinagar—Delhi; (4) Delhi-Lahore — Delhi; (5) Delhi—Karachi—Delhi; (6) Delhi—Amritsar—Kabul; (7) Delhi—Agra—Gwalior—Bhopal—Indore—Aurangabad—Bombay; (8) Delhi — Bikaner — Jodhpur—Ahmedabad—Rajkot.

External Air Routes

In the field of international air transport Air India International has made good progress. Air India International with its fleet of 10 aircrafts provides services reaching out to 19 countries and covering a total route-mileage of 23,483. During 1957-58, it carried 88,312 passengers on its service and its aircraft flew over 67,19,000 miles. There are four weekly services between India and the U.K.; twice-weekly services between Bombay and Nairobi and a service between Bombay and Singapore *via* Madras. Regular external services are being maintained to Cairo, Rome, Paris, Geneva, London, Aden, Nairobi, Bangkok, Singapore, Ceylon, Burma, Nepal, Pakistah, Afghanistan and Australia. Several foreign airlines have air services in the Indian Union. These foreign lines are :

(1) Air Ceylon Ltd., Madras.

(2) Air France, Calcutta, Bombay, New Delhi.

(3) B.O.A.C.—Bombay, Calcutta, New Delhi.

(4) Cathey Pacific Airways, Calcutta.

(5) K.L.M.I. Royal Dutch Airlines, Bombay, Calcutta, Madras, New Delhi.

(6) Pakistan International Airlines Corporation, Bombay, Calcutta, New Delhi.

(7) Pan American World Airways, Bombay, Calcutta, Delhi.

(8) Qantas Empire Airways Ltd., Bombay, Calcutta, Madras, New Delhi.

(9) Scandinavian Airlines System, Bombay, Calcutta, Madras, New Delhi.

(10) Thai Airways, Calcutta.

(11) Union Aeromaritime De Transport, Calcutta.

(12) Union of Burma Airways, Calcutta.

(13) Trans-World Air Lines.

Night Mail Service

Mention may be made of Indian Airlines' operation of the Night Airmail System. Every night four I.A.C. crafts fly between Bombay and Nagpur; Madras and Nagpur; Calcutta and Nagpur and Delhi and Nagpur. Letters, packets and parcels are redistributed at Nagpur, then flown back to the four main cities.

QUESTIONS

1 Bring forth the factors responsible for the progress of road construction and road transport in India. Discuss their importance in the developing economy of the country.

2. "Considering the vast size and huge population, the lines of communications are not as well developed in India as they are in some of the countries of the west." Account for the same and suggest means and ways for their development and ways for their development in future.

3. Give a detailed account of aviation in India. Draw a sketch-map showing the air routes in India.

4. Give the importance of river transport in the Republic of India and trace its development within the last ten years.

CHAPTER 33

Trade

Trade is a symptom of civilization. The economic progress of a nation or an individual is based upon trade. One nation or individual exchanges its surplus production for the surplus of another nation or individual. In this way, everybody tends to produce only that commodity for which nature has given him the greatest capacity. Climate, topography and social organisation determine the capacity for production. They also, on the other hand, determine the needs (in other words market) for commodities. The origins of trade are thus the function of geography.

India contains a little more than one fifth of the total population of the world. Yet, the poverty of her people prevents her having a large trade. The total foreign trade of India is less than that of Great Britain whose population is only about one-sixth of India's. Even the internal trade of India is far below the standard expected in modern times from a country with such a large population. The smallness of India's trade is due to her low production. We have noted in this book our backwardness in agriculture, as well as in industries. We do not produce enough; and unless we produce enough, we cannot have large quantities of goods for exchange or be rich. India's problem is, therefore, one of Production first and of Distribution second.

India is essentially an agricultural country, and her trade, both internal and external, must be characterised, therefore, by the movement of heavy commodities. The paucity of roads and railways is a great drawback in this respect. The difficulties of transport limit the markets for Indian produce. The building of railways and roads in India, and the cutting of the Suez Canal across the Isthmus of Suez opened up new markets for India's agricultural products. With her increased exports, India could now buy larger quantities of goods produced in the world, especially in Europe. The trade began to grow considerably in volume, therefore, since the last quarter of the 19th century.

The foreign trade of India is of great significance, for it is this which provides the country machines, chemicals, raw materials and manufactures without which we cannot progress.

The following are the salient features of our foreign trade :

1. Our foreign trade is carried mostly by sea.

The yearly average of the total sea-borne trade of India in merchandise on private account alone amounts of Rs. 350 crores.

2. The per capita share of the foreign trade of our country is much lower than in Europe or America or Japan.

Per capita foreign trade in India and some important countries is given below 1956 (in U.S. Dollars).

Canada	444	France	146	Egypt	40
Australia	415	U. S. A.	131	Iraq	165
Denmark	349	W. Germany	71	Israel	258
U. K.	305	India	8	Turkey	29
Japan	17	Pakistan	11	Cyprus	327

3. During the war and post-war years, in the composition of India's foreign trade, the share of imports of raw materials is on the increase while the share of exports of raw materials to the total exports have declined. This situation can be accounted for by two reasons : *Firstly*, as a result of partition,India lost many of her raw material markets like cotton, jute, foodgrains; *Secondly*, industrial development as a result of plans has necessitated the heavy imports of raw materials as well as the increased use of domestic raw materials. In exports we have lost heavily in raw jute, raw cotton, oilseeds, shellac, hides and skins, tobacco and spices.

4. The imports of manufactured articles are steadily declining but their exports are on the increase. This change is due to India's policy of encouraging exports of manufactured articles and partly due to a relative improvement in the industrial position of the country.

5. Our trade is now increasing with U.S.A., Australia and other Far Eastern countries and that with the U.K. is on a decline.

6. For some time past our balance of trade has been unfavourable as would be clear from the following figures :

Balance of Trade in Lakhs of Rs.

1950-51	22,01	1956-57	229,13
1951-52	238,24	1957-58	400,59
1952-53	124,52	1958-59	235,50
1953-54	76,61	1959-60	206,00
1954-55	63,91	1961-62	429,50
1955-56	116,50	1962-63	383,50

The foreign trade of India has undergone many changes during the last few years, owing to the effects of the World War and the partition of the country. The export and import of commodities is no longer completely free. Licences are now required for this purpose from the Government. The control of our foreign trade has been necessitated :

(a) because there is a shortage of some raw materials in the country, *e.g.*, raw cotton and raw jute, and, therefore, their minimum supplies for home use must be guaranteed.

(b) because there is a shortage of dollars in the wo rld, and therefore, exports to dollar areas must be encouraged. For it is with the dollars that a large part of our food, our machinery, and other manufactured articles are paid for.

(c) because our resources of foreign exchanges or money with which we pay for our imports are limited, and, therefore, we cannot import as well as we like.

In this respect, it is important to remember that the currencies of the world are divided today into *hard currency* and *soft* currency. The dollar (American currency) represents the *hard*, and the £ sterling (British currency) the *soft currency*. Export to the hard currency areas and imports from the soft currency areas are to be preferred. The payment for the imports is made with the exports commodities or labour or foreign money. As the hard currency areas export more to other countries than they buy from them, therefore, these other countries are always anxious to get dollars from any source they can to pay the hard currency areas. This fact has, therefore, led to the control of foreign trade in all the soft currency areas.

The following table shows our trade with Sterling and Dollar areas since 1952-53.[1]

Year	Sterling Area		Dollar Area		O. E. E. C. Countries		Rest of non-Sterling Areas.	
	Imps.	Exps.	Imps.	Exps.	Imps.	Exps.	Imps.	Exps.
	(In crores of Rs.)							
1952-53	272	292	214	139	99	66	85	80
1954-55	334	335	101	115	134	65	88	79
1955-56	298	310	98	110	157	81	126	96
1956-57	333	313	116	112	225	65	159	109

During the Second World War trade control became very much marked, due to war requirements. After the War the control was necessary for economic rehabilitation in India, the creation of Pakistan complicated this issue considerably. But in order to expand trade without detriment to internal requirements export export controls were liberalized in 1949. They had been in force since the War because of the internal shortage of goods. Subsequently, they were found helpful in developing exports and thus earning foreign money. In

1 Reserve Bank of India Bulletin, March, 1959, p. 409.

1950, certain restrictions had to be imposed against the exports. However, after the heavy adverse balance of our foreign trade in 1949, the emphasis was shifted from export control to export promotion.

In recent years India has imported more than she has exported. The value of the foreign trade of Indian Republic is given below :

Year	Imports		Exports	
1950-51	581	(Crores Rupees)	579	(Crores Rupees)
1955-56	653	,,	597	,,
1960-61	1003.2	,,	648.3	,,
1961-62	109006 lakhs	,,	65517 lakhs	,,
1962-63	113148	,,	67815	,,
1963-64	122285	,,	78928	,,
1964-65	126331	,,	81141	,,

The following table shows the most important items of the import trade in crores of Rupees :

Foreign Trade of India (In crores of Rupees)

Year	Imports	Exports with re-exports	Total value		Balance of Trade
1950-51	650.46	600.68	1,251.14	..	49.78
1955-56	774.36	608.83	1,383.19	..	165.53
1960-61	1,122.48	642.32	1,764.80	..	480.16
1961-62	1,090.08	661.99	1,702.06	..	378.08
1962-63	1,077.15	694.00	1,133·82	..	233.10
1963-64	1223.75	793.25	2017.00	..	430.50
1964-65	1262.81	814.56	2077.37	..	448.25

Indian Foreign Trade

In order to develop the exchange of goods international trade agreements have been concluded with 24 countries and payments agreements with many countries. These international agreements, however, have not been sufficiently utilized to our best advantage primarily due to an inadequate number of business men and business bodies as well as due to the latent mistrust towards new entrants in international business and the traditional bonds which the established foreign business houses enjoy owing to former contracts, privileges, invested capitals *etc.*

On the other side, increasing business contracts of foreign businessmen with the Indian enterprises, more and more frequent visits to India by them, the quality and reliability in the execution by India of the contracts, the growing acquaintance with the operative aspect of Indian foreign trade, have resulted in creating and increasing confidence in ourselves as newcomers in international trade. All these bring about an increased exchange of goods in newer lines.

That the possibilities of the Indian foreign trade are not yet sufficiently known in the foreign markets may be attributed also to the administrative, economy and organization of foreign trade in the pre-independence. The exports and imports in this period were carried out by the enterprises managed by the Government administration and therefore the number of countries taking an effective part in the Indian foreign trade was rather restricted. Thus the manufacturers had no influence whatsoever not only on foreign trade but also in the home market. With the introduction of the National Government and new economic system and the abolition of administrative management of trade, the foreign trade has now been decentralized and liberalized. Towards this task neither our own experience was good enough nor was it possible to apply systems prevalent in other countries.

As the pattern of export-import trade remained the same in the first years after independence, the Indian foreign trade exchange was dominantly done with European countries. This was necessary in order to complete the various industrial projects. Now that these projects are completed and working not only at full capacity but are also constantly enlarged, making in turn available larger export surplus, a furtherance and re-orientation of Indian foreign trade is considered necessary.

Pattern of Trade

The successes of our economic policy in the foreign section are not confined to the rapid increase in foreign turnover. The greatest change which has occurred in imports is the growing share of machinery and other industrial installations and means of transport. These imports began to play an outstanding role during the period of the Five Year Plan.

The imports of raw materials for our expanding industry have also risen considerably, especially those for heavy industry, accompanied by an increase in the imports of other raw materials such as, for example, liquid fuel and machinery, the need for which is mounting along with the growing number of motor vehicles in the country.

In connection with the realization of the programme of speedily raising the standard of living of the population, the imports of raw materials for light industry such as wool, jute, raw materials for other industry, etc., have risen considerably in 1960. Foreign trade plays an

important part in supplies for agricultural implements. Above all, however, we should mention here the imports of chemicals and machinery and raw materials for the production of fertilizers, which are now many times higher than before the freedom. The following table shows the imports of principal commodities.

TABLE CLI : *Imports of Principal Commodities*

Commodity	Value in Rs. lakhs 1961-62	1962-63	1963-64	1964-65
Machinery other than electric	23699	25055	28112	31632
Iron and Steel	10781	8901	9315	10735
Petroleum Products	5329	5750	5822	4133
Transport equipment	6462	7205	7106	6759
Electric machinery and appliances	6591	6478	8480	8877
Raw cotton	6266	5692	4884	5808
Wheat, unmilled	9387	11309	13484	17553
Petroleum crude and refined	4236	3015	4617	2723
Chemical elements and compounds	3559	3807	3211	3476
Manufactures of metals	1795	2094	1582	1624
Textile yarn and thread	1326	1305	1070	1278
Ordnance	122	235	101	1
Copper	2345	2528	2607	2441
Rice	1873	2701	3750	2612
Medicinal and Pharmaceutical Products	1130	928	864	827
Fresh fruits and nuts	1015	1366	1543	1953
Raw wool and hair	1218	1215	1572	964
Paper and paper board	1595	1335	1225	1285
Oilseeds, nuts and Kernels	943	1001	916	704
Coaltar dyestuffs & natural Indigo	1118	891	526	523
Aluminium	793	1053	646	724
Milk and cream dried or condensed	843	821	854	667
Miscellaneous chemicals & products	1214	1052	952	1059
Zinc	735	902	986	1129

Raw jute and waste	627	335	206	737
Crude minerals excluding coal, petroleum, fertilizers and precious stones	786	903	1016	1180
Vegetable oils	542	396	420	480
Total (including other items)	10,90,06	11,31,48	12,22,85	12,63,31

Exports in pre-war India were of a semi-colonial character. Seventy-two percent of our exports consisted of raw or semi-raw materials intended for further processing 22 percent of agricultural and food articles and only 6 percent of finished goods. Of this refined products represented less than one pre cent.

Today, India's exports present an entirely different picture. As early as at the close of the Five Year Plan (1961) mechanical and engineering goods *etc.* amounted to 3 per cent of our total exports. During the implementation of the Third Plan the share of machinery and installations in our exports has been systematically rising, exceeding 12 per cent last year. In this the most outstanding items are : Engineering goods, machine tools, electrical machinery and industrial installations for sugar refineries and petroleum products. It should be remembered that the shipbuilding and motor industries as well as the production of complete factory installations are entirely new branches of production in India.

A considerable part of our exports is made up of products turned out by our rapidly growing chemical industry, which is manufacturing a wide assortment of goods of a high degree of processing, including dyes and pharmaceutical goods.

The most important position in Indian exports is held by textiles, despite the fact that the proportion to the growth of our total exports the share of textile is decreasing. Indian textile export, however, still plays an important part in foreign economy.

From among other more important export articles mention should be made of metallurgical goods, zinc, Manganese, tea, coffee and chemicals. The following table shows the Exports of principal commodities from India.

TABLE CLII : *Exports of Principal Commodities*

Commodity	1961-62	1962-63	1963-64	1964-65
Tea	12226	12882	12338	12467
Cotton textile (fabrics)	4825	4621	5434	5806
Textile fabrics (other than cotton)	8751	10709	12369	11151

Textile articles (other than clothing & footwear)	7681	6629	6902	8218
Ores of non-ferrous base metals & concentrates	1281	983	973	1455
Leather	2533	2245	2620	2716
Raw cotton (excluding linters & waste)	2075	1704	1684	1422
Fresh fruits and nuts (excluding oil nuts)	2027	2132	3276	3118
Crude vegetable materials, inedible.	1536	1342	1599	1553
Raw wool	919	660	742	888
Sugar (including molasses)	1533	1793	2710	1821
Iron ore and concentrates	1741	1983	3640	3721
Tobacco, unmanufactured	1405	1799	2109	2413
Vegetable oils non-essential)	582	1310	1993	705
Crude minerals (excluding coal, petroleum, fettilizer materials and precious stones)	1196	1314	1205	1302
Textile yarn & thread	1395	1519	1668	1440
Woollen carpets, rugs and mattings	428	433	526	537
Iron and Steel	968	224	361	1070
Coffee	902	761	831	1342
Hides and Skins undressed	822	1071	959	905
Petroleum products	348	368	741	791
Coal, Coke and briquettes	242	280	235	436
Total including other items but excluding re-exports	65517	67815	78928	81141

Between 1960-65, with the 20 per cent increase in our overall trade turnover. A special place in our turnover is occupied by America. The trade agreements concluded with America immediately after freedom enabled us to satisfy our most vital requirements both in the sphere of grain and foodstuffs for the population and of raw materials and machines indispensable for starting up industry.

There has been a favourable development of trade between the two countries—India and the U.S.S.R.—since the conclusion of the trade agreement, which provided for all-round promotion of trade between them on the principles of equality and mutual benefit. The assistance from the Soviet Union is not limited to the supply of investment goods.

Of tremendous importance to India is the scientific and technical aid permitting us to take advantage of the rich experience of leading Soviet science and techniques, the transfer of licences and the opportunity of training our cadres in Soviet Schools and work establishments. We also receive grain and some consumer goods from the Soviet Union. The trade agreement also provides for the exchange of films between the two countries and the strengthening of cultural relations in other fields. It will help further to develop trade exchange between Russia and India.

In addition to machinery and installations for industry, building, transport and agriculture, the United Kingdom supplies us with certain basic industrial raw materials, as, for example, Iron ores, non-ferrous metals, engineering goods, raw materials for the fats industry and many others.

India exports an extremely wide range of articles to the U.K. In addition to coal, coke, jute, coffee and other industrial raw materials we also export certain types of machine-tools, and industrial consumer goods, textiles of every kind, china, tea, rubber, *etc.* India has the largest trade with the United Kingdom not only because we had been under the British rule in the past but also because Britain owes us money on account of the last World War. This money is known as the "Sterling Balances". We can get back this balance only in the form of goods.

Britain supplies us mainly manufactured articles, and buys from us raw materials and tea. The following tables show the extent of our trade with Britain :

INDIA'S TRADE WITH U. K.

Principal Exports To

(Figures in £ thousand)	Full year 1954	Full year 1957
Total of All Exports	148,595	157,571
of which;		
Tea	76,963	84,342
Leather, leather manufactures and dressed furs	13,271	13,348
Tobacco and Tobacco manufactures	6,910	7,141
Hides, Skins and Furs, undressed	974	..
Wool and other animal hair	55,67	4,576
Cotton	2,584	2,263
Miscellaneous textile fibres and waste	1,070	1,137
Metalliferous ores and scrap	3,081	4,559

Miscellaneous animal and vegetable crude material, inedible	4,528	4,370
Animal & vegetable oils; fats greases & derivatives	1,892	3,743
Miscellaneous textile manufactures	16,442	12,105

Principal Imports from U. K. (1954 & 1957)

	Thousand £	
Total All Imports	114,907	176,415
of which :		
Machinery other than electric	28,001	45,502
Electric Machinery, Apparatus, etc.	14,836	21,973
Wool and other animal hair	4,929	6,087
Petroleum and Petroleum products	4,610	2,266
Chemicals	15,127	16,561
Paper, Pasteboards and manufactures	1,331	1,658
Iron and Steel	5,891	13,280
Non-ferrous base metals	1,653	3,105
Manufactures of metals	5,080	17,262
Railway Vehicles	3,052	5,559
Road Vehicles and Aircraft	9,363	21,037
Scientific Instruments; photographic and optical goods, Watches and Clocks	2,239	2,846

Where we look at the geographical distribution or the direction of our foreign trade, we note that the largest share of this trade is with United Kingdom and U.S.A. The largest share of our imports (26%) and the largest share of our exports (31%) was accounted for by the United Kingdom. The U.S.A. came next with 12% and 15%, Australia, Egypt, Iran, Italy, Japan are other important countries in our foreign trade.

Yugoslavia and Germany (West) and partly Hungary, supply India with considerable quantities of industrial installations and motor vehicles. Apart from this, we import from the countries of peoples democracy chemicals, zinc, concentrates, aluminium, and industrial articles of mass consumption. Hungary, Rumania, Bulgaria and Italy also supply us with various food and agricultural articles. Our exports of these countries cover not only coal, coke and jute but also tea, coffee, textile goods and a number of other articles.

Since 1950, India has been rapidly developing her economic relations with U.A.R., France and Netherlands. Among the articles we import from South East Asian countries are metal ores, raw materials for the industry while in return we export metallurgical goods, machine tools,

railway rolling stock, motor vehicles and agricultural machinery and implements. We have started exporting to South Eastern Asian countries complete industrial installations, namely, complete installations for Sugar refineries, designed and entirely executed in India. Indian ports are linked with South East Asian countries ports by regular shipping lines.

Poland has trade agreement with India from 1949, which is being extended for 1960 the validity of the lists of goods exchanged between the Polish People's Republic and the Republic of India was signed in New Delhi. The lists provide for Indian exports to Poland of iron ore, shellac, tea, dried hides, coffee, *etc.*, as well as for the exports of the following Polish goods to India : Machine tools and other machines and installations for industry, railway rolling stock, tractors, agricultural implements, chemical goods, textiles, agricultural foodstuffs, fancy goods, *etc.* For example, recently, the Indian Board of Railways decided to buy from Poland 2,600 covered goods wagons.

In the period when there was a coal shortage in Europe after the War, Indian coal helped the countries of Europe to solve the difficult problem of fuel supplies.

On the other hand, India was an important purchaser of machinery and capital installations and of certain raw materials from these countries. Our imports included machinery and industrial installations, motor equipment, non-ferrous metals and their ores, metallurgical goods, chemicals *etc.* Argentina, Australia and Canada also supply us with various food and agricultural articles.

In later years our trade relations were extended to a number of countries in the Near and Middle East as well as to Latin America. The principal countries to which India exported and the value of exports to each for the period 1961-62 to 1964-65 are shown below.

TABLE CLIII : *Exports to Principal Countries*

Country	1961-62	1962-63	1963-64	1964-65
U. K.	16093	16322	16367	8320
U. S. A.	11573	11432	12989	8525
U. S. S. R.	3221	3825	5210	5143
Japan	4054	3342	5885	2892
Australia	1595	1871	1764	1070
Ceylon	1703	1342	1916	587
Germany (West)	2064	1672	2016	1030
Canada	1760	2219	2119	1283
Burma	527	508	637	272
U. A. R.	1291	1305	1254	1358

France	807	874	1101	596
Argentina	494	808	1008	396
Sudan	1030	896	785	352
Malaya	681	667	1289	701
Singapore	829	940	1745	..
Netherlands	803	972	1136	369
Czechoslovakia	810	1124	1617	793
Kenya	545	554	505	261
Italy	916	957	1134	453
Nigeria	705	615	378	233
Cuba	518	351	401	29
New Zealand	739	626	726	403
Pakistan	954	945	718	489
Indonesia	696	406	241	64
Total including other Countries)	66034	68549	79325	45162

A closer study of the countrywise figures reveals an element of diversification in the direction of export trade, India's exports to the East European countries rose from Rs. 63 crores in 1961-62 to Rs. 144 crores in 1964-65. During the first ten months of 1964-65, exports to these countries had already reached the figure of Rs. 86 crores.

Exports to U.S.A., U.K., U·S.S.R., Japan *etc.*, have been increasing but exports to west Germany, Canada, Sudan, Kenya, Newzealand, Argentina, Italy, Pakistan and Indonesia have either been stagnant or shown a declining trend.

The principal countries from which India imported and the value of imports from each for 1961-62 to 1965 are shown in the table below.

TABLE CLIV : *Imports from Principal Countries*

Country	1961-62	1962-63	1963-64	1964-65
U. S. A.	25554	346,84	44997	43614
U. K.	20015	18556	17146	16212
Germany West	12288	9866	9046	10869
Iran	4735	4588	4799	2881
Japan	5945	6486	6587	7733
Italy	2633	2221	1742	2170
France	1678	1420	1442	1670

U. S. S. R.	3994	5864	6846	7799
Belgium	1186	916	798	869
Switzerland	1075	1042	1207	1165
Australia	2417	2428	1792	2449
Federation of Malaya	1292	1071	1209	1042
Saudi Arabia	1891	1238	2118	1346
Canada	1855	1687	2397	2652
Czechoslovakia	1502	1971	1733	1984
Pakistan	1386	1665	935	1575
Burma	1124	909	845	876
Netherlands	1325	1382	1074	1358
Singapore	900	811	535	384
Sweden	1434	855	1181	1118
U. A. R.	1204	977	1525	1735
Kenya	1168	566	341	743
Sudan	1056	1711	852	901
Total (including other countries).	109006	113148	122285	126331

On the other hand, progress can be noted in the trade exchange between India and overseas countries. India takes part in all international organizations and conferences which set themselves the task of promoting free economic exchange between all countries irrespective of their economic and political systems. India's foreign trade assists the cause of development of economic relations between all countries as an indispensable condition for a relaxation in international tension and national cooperation on the basis of mutual advantages.

Inland Trade

In a country as big as India with the vast population, and inland trade naturally assumes gigantic proportions. India, however, suffers from a great drawback in this respect. Her net-work of communications is not complete. There are extensive areas in India without any road or railway. In spite of this drawback, large quantities of goods are transported over different parts of the country. Before the War foodgrains of different classes (rice, wheat, barley, millets, maize, gram and pulses, *etc.*) formed the most important item of the inland trade of India. Most of these grains travelled only short distances, as they are cheap and bulky and cannot, therefore, stand high cost of transport.

The internal trade of India can be classified under the broad heads of (i) rail borne trade (ii) river borne trade and (iii) coasting trade. Complete

and precise data about total internal trade cannot be had, particularly because reliable statistics of trade by river and other craft such as lorry and carts are not available.

The following table shows some of the important commodities entering into the inland trade of India by rail and rivers.

TABLE CLV : *Rail and River borne Trade*

(In thousand quintals)

Item	1951-52	1955-56	1960-61	1962-63	1963-64	1964-65
Coal & Coke	2020,35	2166,34	3147,95	2932,00	3234,44	3444,22
Raw Cotton	25,63	29,00	37,19	30,00	35,40	28,95
Cotton piece goods	24,81	32,60	26,43	22,76	19,00	19,64
Rice (not in husk)	83,31	164,07	222,83	205,78	218,81	196,91
Wheat	194,64	82,74	306,42	291,21	365,04	377,17
Raw Jute	47,13	35,39	40,15	60,44	48,30	28,11
Iron and steel products	173,69	191,65	370,25	485,69	578,09	647,59
Oilseeds	80,37	94,55	95,09	95,88	94·13	60,30
Salt	126,39	124,08	135,39	167,34	168,58	142,46
Sugar (excluding Khandsari)	62,40	82,93	91,06	116,26	105,32	81,66

The following table gives the Railway-Traffic-Wagon Loadings :

(In Thousands)

	(1952-53	1955-56	1956-57	1957-58
Coke and Coal	2,635	2,772	2,165	2,389
Grains and Pulses	949	972	1,023	1,225
Oilseeds	171	212	219	214
Raw Cotton	108	110	108	104
Cotton manufactures	61	67	58	42
Raw Jute	188	150	207	217
Jute manufactures	21	29	24	25
Sugar	169	170	196	216
Cement	297	412	427	504
Pig Iron	25	41	30	39
Iron and Steel	260	331	389	476
Tea	46	48	52	47

Manganese ore	156	148	180	194
Iron ore	325	387	473	349
Others	6,002	6,912	7,935	8,294
Total of Wagons Loaded	11,413	12,761	13,586	14,335

The table below shows the value of the coast wise trade of India in the year 1955-56 and 1963-64.

TABLE CLVI : *Coast wise Trade*

Value in lakhs of Rupees

Year	Imports Indian merchandise	Imports Foreign merchandise	Imports Treasure	Exports Indian merchandise	Exports Foreign merchandise	Exports Treasure
1955-56	164,54	1370	..	143,77	15,90	6
1960-61	209,89	661	..	2,15,03	7,85	..
1961-62	243,73	346	..	2,62,74	7,28	..
1962-63	240,16	262	..	2,55,95	4,79	..
1963-64	250,62	425	..	2,54,02	690	..

Imports exceeded exports during the period 1955-56, but the trend has reversed from 1960-61.

QUESTIONS

1. Write a note on Modern trends in the foreign trade of India.
2. Write a brief essay on the foreig trade of India.
3. Describe the main items of the Indian foreign trade and explain the recent changes. A.U. 1965.

CHAPTER 34

Ports

Practically all the foreign trade of India passes by sea, because the countries on her land frontier are poor and inaccessible and neither buy nor sell much. This sea-borne trade is concentrated only on a few ports of India. Calcutta, Bombay and Madras handle almost the whole of the sea-borne trade of India. There are, however, a number of small ports both on the west coast and the east coast of India which handle a large amount of this foreign trade as part of the coastal trade.

The geographical factors determining the port sites on the western and eastern coasts are somewhat dissimilar. On the west coast from Cape Monze to the little town of Bulsar the coastal plain is low over extensive areas, its general flatness being broken only by the volcanic hills of Kutch and Saurashtra and the Girnar Hills of crysatalline rock, also in Saurashtra. There are two conspicuous features on this section of the coast: (1) The Rann of Cutch, and (2) the Gulfs of Cutch and Cambay.

The Rann is dry and passable by during the winter months, but invaded by the sea at the outset of the Monsoon.

One of the most important factors in the geography of the west coast of India is the sedimentation, for it has played a very important part in various ways in determining port sites. The general trend of currents impinging on to this coast is from the west, and as the currents set into the Rann and the Gulfs of Cambay and Cutch, they have the effect of increasing the degree of sedimentation. Owing to the fact that strong currents set in, in an easterly direction past the mouth of the Indus, the silt from that river is carried into the Gulf of Cutch and Rann, while currents setting into the Gulf of Cambay prevent the free movement of Tapti and Narbada silt out of the Gulf. The result is that these regions have been silting areas for a long time. It has been estimated that the channel approach to Bhavnagar has silted as much as 40 ft. in the last 50 years.

There is a striking contrast between this section of the coast and that which lies to the south of Cambay. It is mostly low and possessing a flat, deeply indented coast, the extensive gulfs contain waters which are difficult to navigate either by reason of insufficient depths or roughness, while the creeks provide poor harbours because of their tendency to become silted, or because distributories may forsake them. South of Bulsar the Deccan Trap occurs. The coast becomes rocky and island

strewn, and the narrow coastal plain, varying in width from 112 kms. in the north to under 48 kms. in the south, is overlooked by the steep escarpment of the Western Ghats. These features continue southwards until in the extreme south a low swampy coast is again found in the silted Cochin lagoons.

The low coasts on the west have a rainfall below 125 cms., the middle section has from 125 cms. to 254 cms., while the southern area of metamorphic rocks and lagoons has over 254 cms.

In short, the chief drawbacks for ports on the west coast are: shoals, the strong undercurrents, the amplitude of the tide, and the irresistible rush of tidal currents.

In India two classes of ports are met with, *viz.*, the major and minor ports. The major ports are administered by the Central Government and the 'minor ports' by the State Governments. The sheltered nature of a port, the well-laid-out approach channels, the provision of docks, jetties and moorings, the well-laid-out transit sheds, the effective rail connections, the ability to serve a very large portion of the hinterland lying behind the port, the facilities for meeting the requirements of defence and strategy, the comparatively large volume of trade and possibilities of work for shifting all the year round, usually distinguish a 'major port' from a 'minor port'. India has 6 major ports namely, Bombay, Cochin, Madras, Vishakhapatnam, Kandla and Calcutta. They together handled 31.0 million tons of traffic during 1957-58. India has a large number of minor ports (about 225 of which 150 are working ports) of these 18 are more important. These are Kakinada, Masulipatam, Cuddalore, Kozhikode, Mangalore, Tuticorin, Allepy, Bhawnagar, Porbandar, Bedi, Nawalakhi, Okha, Quilon and Surat. They handle about 50 lakh tons per annum.

The following table shows the cargo handled by important ports of India :

TABLE CLVII : *Traffic and Earnings of Major Ports*

Port	Ships entered Number	Ships entered Gross tonnage (lakh)	Imports (lakh tons)	Exports (lakh tons)	Surplus (+) or deficit (−) in earnings Rs. (lakhs)	
Calcutta	1807	128.0	60.8	49.8	(+)	5.16
Bombay	3135	220.4	121.3	52.1	(+)	130.66
Madras	1345	95.8	29.9	14.1	(−)	119.89
Mormugao	731	57·4	2.2	64.0	(+)	72.23

Cochin	1358	48.3	22.6	4.5 (+)	20.95
Kandla	346	28.9	20.5	2.6 (+)	4.86
Visakhapatnam	703	55.0	19.1	19.6 (+)	3.08
Total	9425	633.0	276.4	206.7 (+)	117.05

(A) Ports on West Coast

Bombay. The value of the site of Bombay lies in available depth of water. The minimum depth of the main channel is 10 metres, and there is minimum of 12 meters of water at all stages of the tide in the deep water anchorage in front of the docks. The 12 metres minimum is equal to the maximum available in the Suez Canal through which the major.ty of the ships visiting Bombay have to pass. It has a natural harbour directly on the sea. This harbour is open at all times of the year. Hence her volume of trade is always large.

Bombay's communications with the interior are also good, having connections by Western and Central Railways for the Thal Ghat and the Bhor Ghat, the two points where the wall-like Western Ghat mountains are rendered sufficiently low, are within fifty miles of each other and are behind Bombay. They collect up the communication lines to focus them on to the Port. This means that the productive hinterland of Bombay, producing the surplus essential to every port, extends to include the fertile agricultural lands of the Deccan and also in the Ganga Valley. The hinterland of Bombay extends from western parts of Andhra, Madras and Southern parts of Mysore to Delhi in the north and includes western U.P., Rajasthan, Madhya Pradesh and Bombay.

Bombay's greatest advantage as a good natural harbour is afforded by its island position. The position of the docks in the shelter of the island of Bombay is safe from storms of the open sea. The rail and road communications between the port and the mainland across the narrow creeks provide another advantage to Bombay. Bombay is the nearest large port to Europe and North America with which we have the most of our foreign trade.

Because of the depth of water in the harbour the largest ships visiting India can come to Bombay only. All other ports in India can accommodate only ships of small tonnage. On account of the sedimentation noted above, it is necessary to employ dredgers continuously to keep the channel clear for big ships. The Bombay port has a large number of competitors especially in the ports situated in Saurashtra. Calcutta has an advantage in this respect over Bombay, bacause the geographical conditions near Calcutta do not enable any rival port to develop. Bombay's position is unassailable as a passenger port, because the passenger ships are generally of large tonnage which can be accommodated only in Bombay.

Bombay is the principal outlet for the sptaple roducts of western India and Deccan. From her large quantities of wool and woollen goods, hides and skins, manganese ore, cotton textiles, oilseeds and mica are exported, while cotton piece goods, mineral oil, machinery raw cotton, railway plant, iron and steel goods hardware, dyes, coal, etc. are imported from abroad.

The following figures give the trade handled by Bombay :

Year	Imports (000 tons)	Exports (000 tons)	Total (000 tons)
1945-46	4,548	1,902	6,450
1949-50	4,927	1,358	6,285
1951-52	5,806	1,673	7,479
1953-54	4,775	1,651	6,426
1954-55	5,630	1,594	7,224
1955-56	6,647	3,528	10,175
1956-57	8,239	3,740	11,979
1957-58	9,302	S,805	13,110
1960-61	10858	3962	16820
1961-62	104J0	4130	14540
1962-63	11080	4860	15950

Gujarat Ports

Gujarat with a coastline of about 800 kilometres and with only a small population possesses a number of seaports of considerable importance. By its geographical position Saurashra is best able to serve the trade of Rajasthan and the neighbouring regions. The trade at the Gujarat ports generally benefits from the cheaper wharfage and storage charges. Labour charges are also lower than at Bombay. The trade between Gujarat and Rajasthan is carried by the metre guage and the broad guage without the necessity of change from one guage to the other, as is the case with the trade between Bombay and certain parts of Rajasthan.

The most imporant Gujarat ports are :

(1) Bhavnagar, (2) Bedi Bunder, (3) Port Okha, (4) Navlakhi, (5) Verawal and (6) Porbandar.

1. *Bhavnagar* lies half-way up the Gulf of Cambay on its western side. There is enough warehousing accommodation at the port and a railway connection with the whole of India. Ships anchor about eight miles from the port and cargo is brought to the port by barges. Owing

to constant silting, a new deep harbour was constructed in 1937 which can accommodate two ships at all times of the year.

2. *Bedi Bunder* was the first port to be developed in Saurashtra. It is situated in the Gulf of Cutch, with a long line of sheltered sea coast, and has the unique advantage of being open at all seasons of the year. It does considerable coastal trade. As the sea is shallow, large steamer anchor about 3-4 kms. away from the shore.

3. *Okha* is situated in a detached port. It is located at the extreme north-west point of the peninsula of Saurashtra accessible readily to all steamers trading along that coast. The main disadvantage of this port is that the approach to channel from the sea is circuitous and risky. Another drawback is that Okha is far removed from large centres of population. The sea is deep enough for large vessels and the port is open at all seasons of the year. The important exports consist of oilseeds and cotton; while sugar, chemicals, motor cars and machinery form the imports.

4. *Navlakhi* is the principal port of Morvi and is situated on a spit of land in a tidal creek within the Little Gulf of Cutch. Large vessels can only come within a mile or so to the port after navigating mud banks at the entry to the Little Gulf. However, as the port is not exposed, it can be kept open throughout the year.

5. *Verawal* is roadstead anchorage with masonry piers built at right angles to the shore. It admits of small craft coming along side the landing stage at all stages of the tide.

6. *Porbandar* is also an open roadstead, but with coral reefs protecting the inner harbour. There is a considerable traffic, which includes passenger traffic with East Africa. The harbour is closed during the monsoon.

7. *Kandla.* To take the place of Karachi, which is now in Pakistan, the Government of India has developed Kandla as a major port. Kandla is situated about 48 kilometres from the town of Bhuj and is at the eastern end on the Rann of Cutch. The water here has generally a depth of 10 metres, but there is a sandbar near the opening to the port, which reduces the depth. The rail connections with Deesa-Radhanpur on the meter guage and with Jhund on the broad gauge have been constructed. The supply of drinking water has also received attention. A colony has already been built at Gandhidham near Kandla. Kandla has a natural sheltered harbour whose creek is easily navigable. Its hinterland extends from Kutch and Saurashtra to northern part of Bombay, Rajasthan, Punjab, Kashmir and Western U.P. The hinterland is rich in fisheries, cement and glass materials, gypsum, Ignite and bauxite.

After the completion of the port fully these facilities will be available at Kandla : (i) four deep water cargo berths, (ii) five mooring berths in the stream; (iii) four warehouses; (iv) a floating

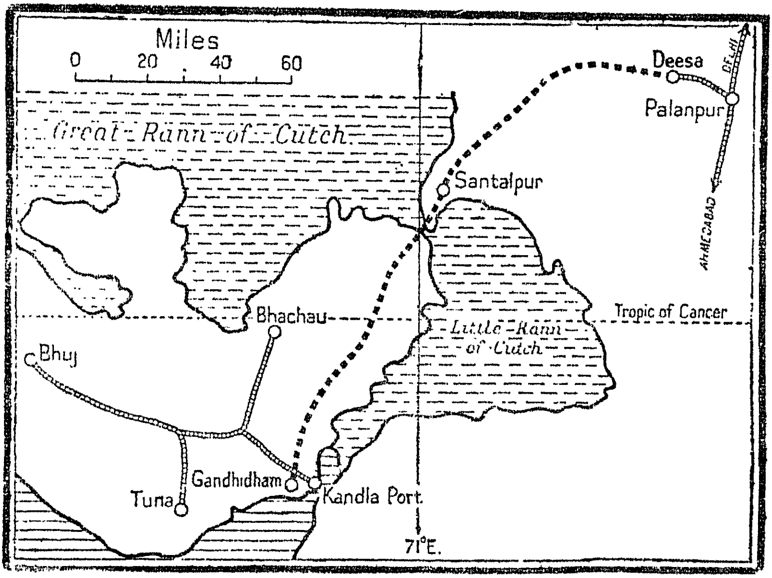


Fig. 70. Location of Kandla sea port.

dry dock for small crafts; (v) an oil berth to take large tankers and (vi) a floating landing stage for passenger launches. The traffic expected to flow through the port is expected to be about 850,000 tons a year.

The following table shows the trade handled by Gujarat ports.

TABLE CLVIII : *Gujarat Ports*

Ports	No. of passengers embarked and disembarked	Imports in tons 1959-60	Exports in tons 1959-60	Weight of Cargo in ton handled 1959-60
Mondvi	41432	18550	6886	25436
Mavlakhi	153,064	25061	78929	103990
Bedi	1815	36358	314806	351164
Okha	6575	175306	281091	456394
Porbandar	4584	54034	70086	124120
Veraval	11,266	79557	135384	214941
Bhavnagar	..	104863	182316	287179
Broach	..	27589	10881	38470

8. *Kozhikode* (Calicut), lying 144 kms. north of Cochin, a port of periodical importance because during the early monsoon period it is

entirely closed to navigation. Due to shallowness of the sea, steamers have to anchor about 4 kms. off the shore. Exports of this port are coir, coir-goods, coconuts, cocogem, rubber, coffee, ginger, spices, groundnut and fish manures. The imports consist of foodgrains, mineral oil, cotton textiles and machinery.

9. *Coohin* is the port of Kerala lying between Bombay and Colombo. It is open for deep water traffic in the worst monsoons and provides a splendid anchorage for all seasons. The principal articles of export are coir, yarn, coir mats, mattings, copra, spices, coffee, tea, rubber and coconut oil.

The following table gives the trade handled by Cochin.

Year	Imports (000 tons)	Exports (000 tons)	Total (000 tons)
1950-51	1115	248	1363
1955-56	1241	394	1635
1960-61	1647	393	2040
1961-62	1880	490	2370
1962-63	1785	385	2170

(B) Ports on East Coats

Vishakhapatnam. The port of Vishakhapatnam was developed by building an improved harbour in the hope of handling the increased traffic in manganese ore, as most of the manganese ore in India occur in its vicinity. The hopes of increased traffic were belied, owing to the fall in the exports of manganese ore due to world competition. The port is the site of the ship-building docks of the Scindia Company. Vishakhapatnam is situated on the Coromondal Coast about 800 kilometers south of Calcutta and 350 kms. north of Madras. It offers better facilities for trade to Orissa and eastern part of Madhya Pradesh in contrast to Calcutta. Its hinterland stretches from northern Madras, Andhra to Orissa and Madhya Pradesh. The chief articles of export are hides and skin, timber, myrabolams, groundnuts, and manganese. Cotton Piece-goods, iron and machinery are its chief imports.

The following table shows the trade handled by Visakhapatnam

TABLE CLIX : *Trade Handled by Visakhapatnam*

Year	Imports	Exports	Total
1950-51	68	892	960
1955-56	232	1112	1344
1960-61	1386	1463	2749
1961-62	1400	1460	2860
1962-63	1375	1450	2825

Madras. Madras is another important port on the coast serving the hinterland of Eastern Deccan plateau embracing the States of S. Andhra, Madras, West Mysore. But it suffers from two serious defects, *viz.*, its hinterland does not produce things which are required by European markets and secondly, many small ports on the Coromondal and Malabar coasts compete with it.

Madras harbour is the only port on the east coast which can admit vessels upto 26 feet draft. It is an artificial harbour, enclosing about 200 acres of sea by quay-walls. Due to cyclonic disturbances during October-November ships have to leave the port.

The chief imports of Madras are coal and coke, foodgrains, mineral oils, metals, timber, textiles, chemical and machinery, while exports consist of hides and skins, turmeric, groundnuts, mica, tobacco and textiles. The following table shows the trade handled by Madras :

Year	Imports (000 tons)	Exports (000 tons)	Total (000 tons)
1945-46	1,833	336	2,199
1949-50	1,592	191	1,783
1950-51	1,929	248	2,278
1953-54	1,569	471	2,041
1954-55	1,594	465	2,059
1955-56	1,716	485	2,201
1956-57	2,033	683	2,716
1957-58	1,885	618	2,503
1960-61	2094	896	2990
1961-62	2270	1200	3470
1962-63	2172	1080	3253

Calcutta. Calcutta is the largest port in India. It is situated about 80 miles away from the seashore. The Diamond Harbour has been built near the sea on the Hooghly for the stay of ships waiting the favourable tide for ascending to Calcutta. In Calcutta for loading and unloading of goods permanent docks have been built at Kidderpore.

Like all other estuarine ports, Calcutta's shipping is at the mercy of the tides. The ships can enter and clear the port only at fixed hours corresponding with the tides. There are also a number of sandbars in the Hooghly which determine the size of the ocean-going ships by the depth of water. The sandbars are particularly numerous in the Hooghly, because of its tortuous course reducing the speed of the flow of the water and causing deposition of silt. The silt brought down by the Damodar river also causes sandbars.

The bars and crossings encountered in the river on the journey to the open sea are Panchparia Crossing, Sankrall Crossing, Manikholi Cossing, Pir Serang Crossing, Poojali Crossing, Moyapur Bar, Royapore Crossing, Fulta Crossing, East-Gur Bar (known also as the Jams and Mary), Kukrahatti Crossing, Balari Bar, Auckland Bar, Saugor Crossing, and Middleton Bar.

While these names may appear somewhat meaningless to the layman, to those connected with the river they are of paramount importance. For instance, Saugor Crossing is the controlling bar in the river. At this crossing there is perhaps only 24 to 30 feet of water—at times little more—and before the ships can enter or leave the port it must be conclusively ascertained that there is sufficient water on the bar to take a ship of any large draught.

This is only one of the many points which have to be carefully checked by the pilot before navigation operations are started.

Cases have been known where a ship has crossed the controlling bar with but a few inches of water under her keel—and on more rare occasions vessels have actually scraped sand. More often than not ships anchor at Saugor, and wait for the next tide. Of course certain vessels, for instance, the Rangoon Mail steamers make the journey very rapidly sailing up or down the river in roughly eight hours. To shorten the distance, there is a proposal to dig a canal from Calcutta to the Diamond Harbour. The length of this canal will be 30 miles.

Calcutta has the advantage, on the one side, of being at the head of the Indo-Gangetic Basin which is the most densely populated area in India. On the other hand, it is at the head of the biggest estuary of the Ganga, in the Bay of Bengal. It is also connected easily with the eastern coastal plain and with the interior of the Plateau Region. It is naturally the largest town of India. The port is well connected by railways, roads and the river to its hinterland which extends from Assam, West Bengal and Bihar to U.P., parts of Punjab, Orissa and Madhya Pradesh. It also has the advantage of having in its hinterland a jute industry depending exclusively on foreign trade, India's premier coal mines, iron mines, petroleum mines, mica mines, manganese mines, and the tea estates, the products of all of which find their foreign market throughout Calcutta. The iron smelting industry of India producing pig-iron for export is also in its hinterland. Other industries of the hinterland are rice-mills, tanneries, cotton mills, paper mills, perfumeries and match factories. Under circumstances, Calcutta is bound to be an important port of India. From the nature of things, Calcutta's trade is mosly in bulky and heavy articles which are not as valuable as the articles handled at Bombay. Owing to the tedious and dangerous river journey, passenger traffic at Calcutta is not large. It is mainly with Burma. This traffic is handled in small ships, for the big passenger ships of the regular lines never visit Calcutta owing to the diffi-

culties of river navigation. The principal exports of Calcutta consist o raw and manufactured jute and jute bags, tea, mica, coal, iron ore, manganese, shellac, wood, iron and steel products, oilseeds. while the important imports are liquor, salt, chemicals, sugar, motor-cars, paper, petroleum, rubber, iron and steel goods and cycles.

The following table gives the figures of trade handled by Calcutta :

Year	Imports ('000 Tons)	Exports ('000 tons)	Total ('000 Tons)
1951-52	4,093	5,489	9,582
1952-53	33,19	6,354	9,673
1953-54	2,723	5,336	8,059
1954-55	3,240	4,573	7,813
1955-56	3,409	4,621	8,030
1956-57	4,353	4,342	8,695
1957-58	5,515	4,640	10,155
1960-61	5405	3945	9350
1961-62	4380	4420	9400
1962-63	5480	4723	10203

The three ports of Bombay, Calcutta and Madras are administered by Port Trusts which are statutory bodies set up by the Bombay Port Trust Act 1879, the Calcutta Port Trust Act 1890 and the Madras Port Trust Act 1905.

Cochin, Kandla and Visakhapatnam are administered directly by the Central Government. The intermediate and minor ports are administered by State Governments.

QUESTION

1. "The importance of a port depends mainly upon the extent and productiveness of its hinter land". Discuss this with special reference to Bombay, Kandla, Caltta and Madras.

CHAPTER 35
Population

Factors affecting the distribution of population. The populaton of India is very unevenly distributed over its surface. Both natural and cultural factors are involved in any explanation of the distribution of the people on the earth, but the great differentiations in population density can be explained to a large degree by natural factors. Those factors affecting the distribution of population include rainfall, temperature, relief features of the earth, water supplies, soil conditions, or location with regard to trade routes and world markets. In addition to the above mentioned geographical factors a number of non-geographical factors are also responsible for the distribution and accumulation of population in different parts of the Indian Union.

The factors which determine the pattern of population distribution are as complex and varied. These factors may be grouped under three classes :

(a) Geographical factors, including climate, landforms, soils, other physical resources, and space relationships.

(b) Cultural factors, including the attitudes and aims of the people, their economic activities and techniques, etc.

(c) Demographic factors, including different birth and death rates of various areas and currents of migration.

There is general agreement that physical conditions such as nature and degree of fertility of the soil, the configuration of the surface, climatic conditions, and spatial relations affect population distribution.

Among cultural factors which have been emphasized as having an important bearing on the distribution of population are the types of economic activities in which people are engaged, the techniques of production, the form of social organization and the objectives which society seeks to attain.

Growth of Population

The census held in 1901 recorded a total at 23.83 crore in the territories now comprising the Indian Union. Since then, India's population has been rising at varying rates pecxet during the decade 1931-21 when it fell by 0.31 per cent and the present population is estimated at more than 47 crores—double the 1901 figure.

The growth rate of India's population was 5.75 per cent during the decade 1901-11,11 per cent during 1921-31, 14.22% during 1931-41 and 13.31 per cent during 1941-51. The population increased from 36.10 crores in 1951 to 43.92 crores in 1961, recording the growth rate of 21.51 per cent.

Among the states, Assam has always shown the highest rate of growth. Even in the decade 1911-21 when most of the states showed a fall in population, Assam's population rose by 19 per cent. During the decade 1951-61, Assam's population rose by 31.45 percent, followed by West Bengal, Gujarat, Rajasthan and Punjab, where population increased by 32.80, 26.88, 26.20 and 25.86 per cent respectively. Indications are that the present growth rate will continue showing an upward trend during 1961-66, and in all likelihood it will rise to 49.47 crores in 1966. Therefore, the growth rate is expected to raise the population figure to 55.96 crores in 1971, 63 crores in 1976 and 69.49 crores in 1981. India's population has doubled in the past 63 years, according to current estimates. The following table shows the growth of population in India since 1901.

TABLE CLX : *Population of India at each census,* 1901-1961, *showing decennial percent variations*

Year	Population	Decennial % variation
1901	236,281,245	
1911	252122,410	+ 5.73
1921	251,352,261	– 0.31
1931	279,015,498	+ 11.01
1941	318,701,012	+ 14.22
1951	361,129,622	+ 13.31
1961	439,235,082	+ 21.50

Distribution of Population

Not only has the population of the Indian Republic increased rapidly, but great changes have taken place in its distribution. Before the First Five Year Plan was launched, the position was that the Indian economy had been practically in the state of stagnation for many decades. Economic development had barely kept pace with the growth of population progress in the field of industry, and commerce was lop sided. Before the industrial Revolution, when India was mainly an agricultural country, the majority of the inhabitants lived in the fertile lowlands which lie north of the Deccan and east of Rajasthan.

The Indo-Gangetic plains of India and coastal regions, *etc.*, have remained overcrowded since ages past. A French geographer, Vidal de la Blache remarks on the fact that the most densely inhabited tracts are those where rice is chiefly grown, and attributes this to its nutritive power: It is grown everywhere in the whole Indo-Gangetic plain and West Bengal. States that have much agricultural land, but which have some industrial areas or are near large population centres, have a density varying from 500 to 1500 people per square mile. Included in this group are such states as Bengal, Kerala, Madras, U. P. and Bihar. The following table shows the Area, total population and density of India.

TABLE CLXI : *Area Population and Density* 1961

India	*Area (sq. miles)*	*Population*	*Density*
Andhra Pradesh	106,286	35,983,447	339
Bihar	47,091	11,872,772	252
Gujarat	72,245	20,633,350	286
J. & K.	N.A.	3,560,976	N.A.
Kerala	15,002	16,903,715	11,27
Madhya Pradesh	171,217	32,372,408	189
Madras	50,331	33,686,953	669
Maharashtra	118,717	39,553,718	333
Mysore	74,210	23,586,772	318
Orissa	60,164	17,548,846	292
Punjab	47,205	20,306,812	430
Rajasthan	132,152	20,155,602	153
U. P.	113,654	73,746,401	643
W. Bengal	33,829	34,926,279	10,32
Union territories & other states			
Andaman & Nicobar Islands	3215	63,548	20
Delhi	573	2,658,612	46,40
Himachal Pradesh	10,885	1,351,144	124
Loccadive, Minicoy & Amindivi Islands	11	24,108	21,82
Manipur	8,628	780,037	90
Tripura	4036	1,142,005	283
Dadra & Nagar Haveli	186	57,963	307

Goa, Daman & Diu	1426	626,978	440
NEFA	31,438	336,558	11
Nagaland	6,366	364,200	58
Pondicherry	185	369,079	1995
Sikkim	2744	162,189	59

Kerala in the extreme south west of the Indian Republic has a population of 16,903,715 with an area of 15,002 square miles. It falls naturally into two parts—the western littoral and deltaic, and the Eastern mountainous and sub-montane. There are on the average 1127 persons to the square mile, but there are extraordinary local variations. In the western district (Alleppey) the number is 2595 against 745 in the Eastern (Kottayam). The latter tract has a heavier rainfall, but the surface is so broken that half the total area is unfit for cultivation. The soil is relatively very poor and the climate unhealthy. Two districts of Kerala state have a density exceeding 2000 and three have a density over 1000 to square mile. The districts mainly dependent on agriculture only have under 1000 per sq. mile. Finally, the very mountainous districts have less than 600 persons per s.m.

The state of West Bengal (including those portions of Purnea and Manbhum districts of Bihar state which have been added to this state after reorganization of states), has a population of 34,926,279 persons and an area of 33,829 sq. m. Its density on the average is 1032 persons per sq. m. and is far greater than that of any other state of the Indian Republic. It is nearly double that of Punjab, more than three times that of Maharashtra and more than four times that of Orissa.

Practically the whole of it is a fertile alluvial plain, in which rice is almost everywhere the main crop. The region of swamp and forest along the sea coast, known as the Sundarbans, is mostly uninhabited. The population is sparse in the north where there are extensive areas of hilly country and reserved forest which are not available for cultivation.

The highest density is found in the metropolitan districts of Calcutta and Howrah. The former has 73,182 persons to the square mile. Even if Howrah city be excluded it still has 3,545, and in no district in the state does the number fall below 500. Jalpaiguri has an average of only 565 persons per sq. mile, and the population of the whole district is about the same as that of a W. Bengal market town. Darjeeling has 624,640 inhabitants with an average density of 538 per sq. mile.

The State of Assam has a population of 11,872,772 with an area of 470,91 sq. m. The population of Assam increased during the ten years preceding the census by 3042,040 or nearly 34.45%. United Mikir and North Cachar Hills district shows the highest growth rate of 69.08% between 1951 and 1961 while Cachar shows the lowest of 23.53. The next highest rate of increase, 35.61%, is found in the Mizo

Hills. Taking the figures for individual districts we find in Lakhimpur, at the extreme north east of the State, the increase of 437,548 or 38.85%. The neighbouring district of Sibsagar shows an increase of 296,116 persons or 24.43%. In Nowgong the increase is 35.51 per cent in Kamrup 38.39 percent and Goolpara 39.32%, while Garo Hills shows an increase of 26.91 per cent and Darrong 39.64%.

The population recorded in Bihar by the census of 1961 was 46,455,610. The increase since 1951 comes to 7,671,832 or 19.78 per cent. Among the districts of the state, Purnea comes first with an increase of 37.16%, Saharsa 31.75%, Hazaribagh 23.70%, Singhbhum 20.54%, Dhanbad 27.91% and Palamau 20.49%.

The greatest density is found in Patna (1363), Muzaffarpur (1365) and Darbhanga, and the least in Palamau (241), Ranchi (303) and Hazaribagh (342).

According to the census of India the population of Andhra Pradesh has increased by 15.65% during the decade. Andhra Pradesh as a whole has on an average 339 persons to the sq. m. The highest density (690) is found in Hyderabad district, and the lowest (160) in Adilabad district. Taking the figures for individual districts we find in W. Godavari, the increase of 306,533 or 13.32 per cent. The neighbouring district of East Godavari shows an increase of 280,530 or 16.52%. Krishna has 615 persons per square mile, Visakhapatnam 441, Guntur 519, Medak 331, Nizamabad 329, while Khamman, which is traversed by the sparsely populated semi laterite formation, it drops to 172, the lowest density in the state. In Nellore the increase is 13.33%, in Chittor 14.91 per cent, Cuddapah 15.40% and Kurnool 18.01 per cent, while Nalgonda shows an increase of 23.36% and Mahbubnagar 9.92%.

The area of the Gujarat State is now 722,42 sq. miles with a population of 20,633,350 or 286 persons per sq. m. The greatest density is found in Kaira (754) a district of Gujarat, and least in Kutch (41). The population of Ahmedabad increased between 1951 and 1961 by 534,449 persons or 31.89%. The rate varies considerably in different parts, from 51. 36% in Dangs to 21.27% per cent in Mehsana. The average number of persons to a sq. m. in Jamnagar is 210. Surat has a density of 505 persons per sq. m. In districts the density varies from 516 in Baroda to 299 in Broach. These differences are readily accounted for by the climatic and physical conditions. The sparsest population is found in Kutch (41 per sq. m.) Dangs (104) and Surendranagar (166) and the densest in Kaira. Amerti has 432 persons to a sq. mile and Bhavnagar 241. The mean density of Banaskantha is 274 persons per sq. m. The northern portion is occupied by low hills.

Taking Jammu and Kashmir and Ladakh together, and excluding the population of Azad Kashmir, Gilgit, Chilas, Wazarat and Muzaffarabad, the average density is sparse. No man-land ratio is available

at present. The total population of J. & K. during the year 1961 was 3,560,976. Area-wise figures are not available. The population of J. & K. in 1951 was 3,253,852, in 1961 it was 3,560,976. The increase since 1951 comes to 307,124 or 9.44%. The population of Ladakh was 88,651 (1962). A large number of the inhabitants are pastoral nomads, not merely by habit but by necessity, wandering from place to place in search of grazing grounds for their sheep and goats.

The State of M.P. has a population of 32,372,408 and an area of 171,217 sq. m. and the population density is 189 per sq. m. Its density is far lower than that of any Indian State, it is nearly half that of Andhra Pradesh. On the whole the local variations depend less on the rainfall than on the configuration of the surface. In the level tracts the density is high everywhere, while in the hills it is almost universally low. The greatest density is found in Indore (510) and the least in Bastar (77). The most sparsely populated districts are Surguja (120) Panna (122), Raisen (126), Mandla (134), Shivpuri (140), Guna (140), Betul (144), Sidhi (143), Shahdol (153), Vidisha (Bhilsa) (172), Jhabua (197), Damoh (155), Hoshangabad (160), Seoni (155), Chatarpur (174), Morena (175) and west and east Nimar 165 and 190 respectively. The districts mainly dependent on agriculture only have under 300 persons per sq. m. average (170-250).

Industrial districts, such as Indore, Gwalior, Jabalpur etc., have more than 300 persons per sq. mile.

The area of Madras state is 50,331 sq. miles with a population of 33,686,953 or 609 persons per sq. m. The state has thirteen districts of all sizes, ranging from petty chiefships to as large as Madras and has a greater population. The population of Madras increased during the ten years (1951-61) by 3,567, 906 or 11.85 per cent. Nilgiris district shows the highest growth rate of 31.30 per cent between 1951-61 while N. Arcot shows the lowest of 8.51%. The next highest rate of increase 20.64%, is found in Kanya Kumari. The neighbouring district Tirunelveli shows an increase of 225,276 persons or 8.99 per cent. In Ramanathapuram the increase is 16.33 per cent, in Thanjavur (8.82), Coimbatore and Salem both have 12.78%, Madurai 11.05%, while Chingleput shows an increase of 22.11 per cent and Tiruchirapalli only 8.36 per cent.

Maharashtra extends over 118.717 sq. miles, and has 39,553,718 inhabitants. There are on the average 333 persons per sq. m. or somewhat fewer than Andhra Pradesh. The greatest density is found in the industrial district of Kolhapur (508) and Poona (409), and the lowest Chanda (135) where an extensive area is under forest, the surface is hilly of about three quarters of the total area of the district is cultivated, the principal crops being Jowar and bajra, *etc.* The next densily populated districts are Thana (452), Ahmednagar (409) and Sholapur. These are industrial districts in the state. The density ratio of Ratnagiri is 390 and of Kolaba 364. The Yeotmal district is a medley of hills and

forests with occasional patches of cultivation, and has consequently a sparse population. In Nanded and Osmanabad the density is more uniform, the maximum being 268 and the minimum 225 in Nanded. Nagpur has a very small area of forest, coupled with a copious rainfall, extensive tank irrigation and a fertile soil highly suited to the cultivation of rice *etc.*

The total area of Mysore state is 74,210 sq. miles, with a population of 23,566,772 (1961) and population density of 318 persons per sq. m. The state naturally falls into two divisions, the Malnad and hilly tract sloping down from the Western States, with a density of 200, and the Mandya or open country to the east, with 467. The relatively low density in N. Kanara is due entirely to the configuration of the surface, it has a greater rainfall and better irrigation facilities than Raichur, but the area which is fit for cultivation is much more restricted.

The total population of Orissa is 17,548,846 with an area of 60146 sq. miles and population density of 297 persons per sq. m. The census figures (1961) show an increase in the total population since 1951 of 19.82 percent. Cuttack is one of the most populated districts of Orissa, with a population density of 722 persons per sq. m. Balasore, Puri, Ganjam and Bolangir have a much denser population. The area of Rajasthan is 132,152 sq. m. with a population of 20,155,602 persons and population density of 153 persons per sq. mile. The greatest density is found in the fertile and highly cultivated district of Bharatpur (368 person per sq. m.) in the east of Ajmer division and the lowest in the Jaisalmer district of Jodhpur division where extensive area is covered by sand. Jaisalmer is the second sparsely populated district in the Indian Republic, with a density of 9 persons per sq. m. In Bikaner division the density is more uniform, the maximum being 153 in Ganganagar and the minimum 130 in Bikaner. The generally low density throughout this state is due entirely to its scanty rainfall. With an area, including Haryana, of 47,205 sq. miles, Punjab has 203,06,812 inhabitants, or 430 persons per sq. mile. The population is sparse in the north east where there are extensive areas of hilly district and reserved forest which are not available for cultivation. Lahaul and Spiti is one of the sparsely populated districts in the Indian Union with only 4 persons per sq. m. The highest density is found in agro-industrial districts of Jullundar, Ludhiana, Amritsar and Gurdaspur. In Ferozepur the density is 417, Kapurthala 545, Bhatinda 390, Sangrur 470, Patiala 464, Mahendragarh 408, Karnal 487, Hoshiarpur 558 and Hissar 286.

U. P. is the most densely populated state in India. The total area of U.P. is 113,654 sq. m. with a population of 73,746,401 (1961) and the density is 649 persons per sq. m. U.P.'s extremely fertile alluvial soil produces a variety of crops to feed her increasing population which is now probably growing by over 2.6 per cent per year. Except for the

Himalayan tract, in the north-west and Bundelkhand and Mirzapur in the south, the whole state is a level plain with copious rainfall, a fertile soil and a considerable amount of Irrigation, especially in the Jumna-Ganga Doab. One of its districts, Uttarkashi, is the most sparsely populated in the state. In Uttarkashi the density is 41 and in Chamoli 72. Pithoragarh in the north and Mirzapur in the south have also a very scanty population. The density of both is 95 and 286 respectively.

In the Indo-Gangetic plain the density of population increases steadily from west to east. Included in this group are such districts as Shahjahanpur 641, Farrukhabad (781), Sitapur (719), Rae Bareli (748) and Bara Banki (825). The relation between the amount of rainfall and population in U.P., in general, is universal. Here the amount of rainfall goes on diminishing from east to west and with the decreasing rainfall the density of population goes on diminishing. Agro-Industrial districts have more than 1000 persons per sq. m. The districts mainly dependent on agriculture with some industries only have under 800 to 500 persons per sq. m.

QUESTIONS

1. Give the geographical factors which affect the distribution and density of population in India. Is India overpopulated ? Suggest means and ways for solving the so-called population problem of India.

2. Discuss fully the distribution of population i the uppe Ganges Plain, and point out if there is any tendency towards rearrangement of population.

3. Describe the density of population in the Republic of India, bringing out clearly the areas of highest and lowest densities.

CHAPTER 36

Races of India

The Indian Sub-continent being huge in physical dimension exhibits a variety of human races. Here the highest grade of civilization to the lowest are found side by side. The diverse anthroplogical character of the pre-historic races is still observed among some of the aboriginal tribes of India. The so-called pure racial elements have become extinguished not only in India but in the whole world, due to frequent inter-breeding amongst different human species. Nevertheless, some of the uncivilized and ancient tribal people of the country have survived interbreeding and hence they can be supposed to exhibit that the same original anthropological character of their predecessors. The Indian civilization, as it stands today, is the outcome of the admixture of the frequent immigrants from other parts of the world and its original residents. Under such circumstances it is incorrect to look foi the original, pure races that once dominated the country.

Let us, however, traverse very rapidly the history of race classification of the Indian people using the authoritative study by Sir Herbert Risley.

RISLEY'S CLASSIFICATION

Risley gives a lucid description of the Indian races and their origin. His classification enjoyed the recognition of the people, because of his being the foremost anthropologist to enumerate a scientific anthropometry of the Indian sub-continent. His divisions were :—

The Turko-Iranian

This type is in practically exclusive possession of Baluchistan and the North-western Frontier Province. The portion where the Turko-Iranian race predominates now forms part of West Pakistan· According to Risley its leading characteristics are the following :

"The head is broad, the mean indices ranging from 80 in the Baloch of the Western Punjab to 85 in the Hazara of Afghanistan. The proportions of nose (nasal Index) are fine or medium the average indices running from 67.8 in the Tarin to 80.5 in the Hazara. The stature is above mean ; complexion fair ; eyes mostly dark, but occasionally grey; hair on face plentiful; head broad ; nose moderately narrow, prominent and very long.

The Indo-Aryan Type

The Indo-Aryan type predominates in Rajasthan, the Punjab and the Kashmir valley, though in parts of these areas it is associated to a varying extent with other elements. It is readily distinguishable from the Turko-Iranian. According to Risley the Indo-Aryans have the highest stature recorded in India, ranging from 174.8 in the Rajput to 165.8 in the Arora. Individual measurements of Rajputs rise to 192.4 and of Jat (Sikhs) to 1905..

The Scytho-Dravidian Type

The Scytho-Dravidian type occurs in a belt of country on the west of India extending from Gujrat to Coorg (now in Mysore). It is represented at one extreme of this belt by the Nagar Brahmans of Gujrat and at the other by the remarkable people of Coorg. Excluding the Katkaris, who belong to the Dravidian type, the leading characteristics of the Scytho-Dravidian are as follows :

"The head-form ranges from 76.9 in the Deshasth Brahmans to 79.7 in the Nagar Brahmans and 79.9 in the Prabhus and the Coorgis, while the maximum individual indices rise as high as 92 with the Maratha Kunbis and Shenvi Brahmans". "The mean stature varies from 160 in the case of the Kunbis to 168.7 in the Coorgis and an examination of the figures will show that it is on the whole lower than among the Turko-Iranians."

The Aryo-Dravidian Type

According to Risley the Aryo-Dravidian type or Hindustani type extends from the eastern Punjab to the Southern extremity of Bihar, from which point onwards it melts into the Mongolo-Dravidian type of Bengal proper. It occupies the valleys of the Ganga and Jamuna and runs up into the lower levels of the Himalayas on the north and the slopes of the central Indian Plateau on the south. Its higher representatives approach the Indo-Aryan type, while the lower members of the group are in many respects not very far removed from the Dravidians. The mean stature of the Aryo-Dravidians ranges from 166 cm. in the Brahmans and Bhumihars to 159 in the Musahar, the corresponding figures in the Indo-Aryan being 174.8 and 165.8.

The Mongolo-Dravidian

The Mongolo-Dravidian or Bengali type occupies the delta of the Ganga and its tributaries from the confines of Bihar to the Bay of Bengal. Within its own habitat the type extends to the Himalayas on the north and Assam on the east and probably includes the bulk of the population of Orissa. The western limit coincides approximately with the hilly country of Chhota Nagpur and West Bengal. The stature varies from 167 in the Brahmans of western Bengal to 159 in the Kochh of the sub-Himalayan region.

The Mongoloid Type

According to Risley on its northern and eastern frontier India marches with the great Mongoloid region of the earth. The prevalent head-form is broad but the mean indices show some remarkable departures from this type. The Jaintia index is 72.9, thus falling within the long headed category, and several tribes have indices between 75 and 80. In the larger groups the mean nasal Index ranges from 67.2 for the Lepchas to 84.5 for the Chakmas and 86.3 for the Khasias; the Tibetans (73.9) and the Murmis (75.4) falling between these extremes.

The Dravidian Type

The Dravidian race, the most primitive of the Indian types, occupies the oldest geological formation in India, the medley of forest-clad ranges, terraced plateaux, and undulating plains which stretches, roughly speaking, from the Vindhyas to Cape Comorin. On the east and west of the peninsular area the domain of the Dravidian is coterminous with the Ghats; while farther north it reaches on one side to the Aravalis and on the other to the Rajmahal hills. Where the original characteristics have been unchanged by contact with Indo-Aryan or Mongoloid people the type is remarkably uniform and distinctive. Among the Dravidian of Southern India the mean stature ranges from 170 in the Shanans of Tinnevelly to 153 in the Pulaiyans of Travancore, and individual measurements vary from 182.8 in the former group to 143.4 in the latter.

A.C. Haddon discarded the racial classification propounded by Sir Herbert Risley and replaced it with his own classification. His classification enjoyed the recognition of the people, because of his being the foremost anthropologist to enumerate a scientific classification of the Indian sub-continent.

HADDON'S CLASSIFICATION

A. C. Haddon established three groups sub-divided into eight races. His classification is partly based on geographical location.

I. The Himalayas

The following racial elements are noticed in the Himalayan region:

(a) *Indo-Aryan.* Kanets of the fertile valley of Kulu and some Nepaleses are the true representatives of this type. Their physical features are as follows : fair complexion, dark eyes, tall stature, narrow and prominent nose. The following table indicating the anthropometric data has been taken from Haddon's series.[1]

[1] A. C. Haddon, *The Races of Man*, pp. 114—116.

TABLE CLXII : *Anthropometric data according to Haddon*

Tribes or Caste	Stature	C.I.	N.I.
Kanets of Kulu	1.654 m.	74.3	74.1
Kanets of Lohoul	1.618 m.	77.5	66.4
Gurung	..	81.6	78.5
Limbu	..	79.5	75.2
Gurkha	1.603 m.	84.3	74.1
Lepcha	1.679 m.	75.9	..
Bhotiya	1.570 m.	79.9	67.2
Murmi	1.672 m.	80.3	77.0

(b) *Mongoloid.* The main racial element of the North East Frontier Agency of the Indian Republic according to Haddon is the Mongoloid. The full complex of these features is met with most frequently in Himalayan slopes amongst the Lepchas, Garo, Khasi, Naga, Daffla *etc.* Some Dravidian features are also dominant in Assam and this element might have come from the Southern-Western regions where this Dravidian element is very dominant. The following table indicating the anthropometric data of the Assam tribes, has been taken from Haddon's series.

TABLE CLXIII : *Anthropometric data for Assam etc.*

Tribes or cast	Stature	C.I.	N.I.
Khamti	1.641 m.	79.1	88.4
Singpho or Chingpo	1.603 m.	75.7	80.8
Garo	1.588 m.	76.0	95.1
Khasi	1.569 m.	78.6	86.3
Kuki	1.587 m.	76.0	58.9
Angami Naga	1.639 m.	78.6	82.2
Ao Naga	1.566 m.	80.4	81.8
Daffla	1.606 m.	77.0	84.1
Abor	1.579 m.	77.0	81.6

II. The Indo-Gangetic Plain or Hindustan

The prevailing type in the Kashmir Valley, Punjab and Rajputana is represented by the Jat and Rajput, who have a light transparent brown skin colour and are usually of tall stature; they are very dolichocephalic (C.I. 72-75), with a well developed forehead, a long narrow face, regular features and a prominent straight finely cut leptorrhine nose. The following table indicating the anthropometric data of Indo-Gangetic plain has been taken from Haddon's series.[1]

1 Haddon, *Op. cit.*, pp. 111-114.

TABLE CLXIV : *Anthropometric data for Hindustan*

Castes and tribes	Stature	C.I.	N.I.
Jat	1.716 m.	..	68.8
Rajput	1.748 m.	73.4	71.6
Chuhra	1.666 m.	73.4	75.2
Khatri	1.662 m.	74.0	73.1
Gujar	1.703 m.	72.4	66.9
Hill men of Hoshiarpur	1.680 m.	72.0	70.0
Patiala	1.730 m.	75.0	62.0
Babhan	1.662 m.	76.7	74.0
Chamars of Bihar	1.630 m.	72.8	86.0
Rajbansi	..	83.0	74.6
Kochh Rajbansi	..	75.2	76.6

III. The Deccan

Haddon's divisions are based on distinction of colour, language and cephalic index. The oldest existing stratum, according to him, is represented by different pre-Dravidian jungle tribes. "The Dravidian may have been the original inhahitants of the valley of the Ganges in Western Bengal......after many wanderings, apparently across India, they settled mainly in Chhota Nagpur. According to him the following racial elements are found in the Deccan :—

(a) *Negrito.* The Mincopi people of the Andaman and Nicobar islands, who are regarded by Haddon as "a somewhat generalised variety of Negrito-Papuan Stock", were preserved upto recent times by their isolation in islands about 320 kilometres from the mainland. Haddon has referred to an early dark negroid race in Suciana, and its drift to India is not impossible.

Negrito features are met with particularly amongst the Andaman istanders, and most probably the Uralis of Nilgiri hills, Kadars of Cochin, Pullayans of Palni Hills *etc.*

(b) *Pre-Dravidian.* In the Jungles of the Deccan are to be found primitive types of very low culture, which may conveniently be grouped as pre-Dravidian and according to Haddon, "who form the oldest population of whom we have any knowledge. It forms today a dominant element in the population of Deccan plateau and Bihar. In this region pre-Dravidian culture had a far wider distribution in the historic past is found as Haddon pointed out that "there is very good reason to believe that this group of peoples formerly extended over the greate part

of India and some seem to have acquired a certain degree of higher culture."[1]

(c) *Dravidians.* This type is found in Mysore, Malabar, Cochin and Travancore (now in Kerala) and Nilgiri, with a Dushastha Brahman. Tamil Sudra, Tamil Brahman, Nambudiri Brahmans and Nayar of Malabar, forming the greatest percentage of this type.

(d) *Westtrn Brachycephals.* This type is represented by the Nagar Brahman of Ahmadabad. A zone of relativcly broad-headed people, thc western Brachycephals, extends from Gujarat to Coorg (Mysore) along the western coastal area of India. Dr. Haddon, who first postulated an immigration of the Alpine folks to account for the "strongly marked Brachycephalic element in the population of western India."[2]

(c) *Southern Brachyeephals.* The Southern Brachycephalic type is represented by the Pariyan of Tamil and Parava of Tinneveily. According to Haddon's calculation the average.cephalic index of Nagpar Brahmins is79.7 and of Kodaga it is 79.9. The following table indicating the anthropological data, has been taken from Haddon's series.[3]

TABLE CLXV : *Anthropometric data for Deccan*

Caste & Tribes	Stature	C.I.	N.I.
Kurumba	1.639 m.	..	73.2
Bhil of Mewar	1.629 m.	..	84.1
Bhil of Khandesh	1.649 m.	..	94.9
Ho	1.680 m.	..	..
Juang	1.570 m.	74.5-76	..
Korwa	..	..	92.5
Munda	..	..	89.9
Kharwar	..	..	89.7
Santhal	..	..	88.8
Canarese	1.621 m.	75.4	86.5
Tiyan	1.642 m.	73.0	86.1
Nayar	1.656 m.	73.1	74.2
Vellala	1.624 m.	74.1	76.8
Deshastha Brahman	..	..	73.1
Tamil Brahman	..	..	75.8
Canarese Hindu	1.641 m.	71.7	76.7
Toda	1.698 m.	73.3	75.6

1 Haddon. Op. Cit. p. 107.
2 Haddon, Op. cit., or *Wanderings of Peoples*, p. 27.
3 Haddon, *Races of Man*, pp. 107-111.

Nambudiri	1.623 m.	76.3	74.9
Shanan of Tinnevelly	..	80.7	75.5
Pariyan	..	80.0	77.9
Parava	..	79.4	77.7
Nagar Brahmins	..	79.7	73.1
Prabhu	..	79.9	75.8
Marathi Gati	..	78.3	80.1
Sukun Sale Maratha	..	82.2	74.0
Canarese (Madras)	..	79.0	..
Kodaga	1.687 m.	79.9	72.1
Vedda of Ceylon	1.625 m.	78.8	74.9

HUTTON'S CLASSIFICATION

Dr. Hutton has suggested the following classifications of the ethnic elements in India.

Negrito

According to Hutton, the earliest occupants of India were probably of the Negrito race, but they have left little trace on the mainland of the peninsula. As already indicated traces of this stock are still to be seen in some of the forest tribes of the higher hills of the extreme South of India, and similar traces appear to exist in the inaccessible areas between Assam and Burma, where a dwarfish stature is combined with frizzly hair such as appears to result from recent admixtures of the pure or virtually pure Negrito stock of the Andamans with blood from the mainland of India or Burma.

Proto-Australoid

Proto-Australoid came from the East Mediterranean area (Palestine), and according to Hutton "The safest hypothesis at present therefore appear to be that Proto-Australoid type in India is derived from a very early migration from the west and that its special features have been finally determined and permanently characterized in India itself." The Veddahs, Malavedahs, Irulas, Sholagas are the true representatives of this type.

Early Mediterranean

They brought earlier forms of Austro-Asiatic languages. Dr. Hutton generalising the facts writes, "Nothern India was occupied by Mediterranean races before the Armenoid stock began to mingle with them, and it is possible that they were connected with the In onesian race, now submerged, which seems to have left patches of speakers of Austro-Asiatic languages along both sides of the Ganges Valley in the course of its migrations."

Civilized Mediterranean

They are known as Dravidians in India. They have been acquainted with the mathematical and astronomical knowledge of contemporary Babylonia. This type is responsible for the development of Indus Valley civilization.

Alpine

According to Hutton, "This race appears to have been at any rate partly responsible for the highly developed civilization of ancient Mesopotamia and Asia Minor and in both areas it has everywhere mingled with the Mediterranean race which it found in occupation."

Armenoids

The opinion of most of the Anthropologists is that the Armenoid race resulted from a stabilized interbreed between hook-nosed Mediterraneans and brachycephalic Alpines. The race, characterized above all by its sugar-loaf head form and its convex nose with fleshy depressed tip and flaring wings, has its centre of distribution in the Anatolian plateau of Asia or most "probable that the centre of development of this subrace was in Asia Minor". From there it spread southward to Arabia and eastward at least as far as India.

Nordic

They are supposed to have brought the Sanskrit language in India. Hutton thinks that these types occupied north-western India from the beginning of the fourth millennium B.C., but Dr. Guha states that this large-headed strain found at Mohenjodaro probably forms one of the constituents of the race "whose advent in India appears to synchronize with the Aryan invasion."

Mongoloid

They entered into India from north east territory. And according to Hutton, "The race movement of Mongolians southwards still continued among the Kochin tribes, while the Kuki-Chin tribes have barely settled down after reaching the Bay of Bengal and starting to work northwards again on the Assam side of the dividing ranges. The Bulk of Burma in any case is primarily Mongoloid, and any non-Mongoloid streams of migration that may have reached I dia through Burma have absorbed a vast quantity of Mongolian blood."

The other authoritative classifications (such as propounded by G. Ruggeri, Eicksledt and Dr. Guha) have elsewhere been dealt with by other writers somewhat fully.[1]

1 Also see,

Sarkar *Races of India and Ancient Races of India*, Calcutta.

Balbir Singh, *Anthropography or Race, Culture and Society*, Kitab Mahal, Allahabad,

PRIMITIVE RACES OF INDIA

Geographically, the aborigines of India can be divided into the following groups :—

(i) South Indian Tribes

(ii) North Indian Tribes.

The South Indian tribes may be divided into two groups according to their distribution ; The tribes of south and south west India are :

The hill tribes of south and south-west India comprise of tribes such as Chenchus, Kotas, Paniyans, Todas, Kadars, Uralis, Badagas, *etc.* Broadly speaking, these aborigines may be divided into three groups, according to their economic advancement—

(a) Hunting, (b) Food gathering and (c) Sedentary Agriculture.

The hunting tribes contain the following main types of aborigines :—

(a) Malapandarams of Central Travancore hills.

(b) Chenchus of Andhra and Hyderabad (now in Andhra).

(c) Reddis of Andhra, and Koyas.

The Malapandarams are a very small tribe and their number was estimated at 187 according to the census of 1941. They have not taken to cultivation and live either in a cave or in a very simple type of shed. The temporary sheds are of lean type. Three poles, eight feet high, are so fixed that they converge at the top and the area on which they stand forms a triangle. Leaves of palmyra are then tied to the poles on the sides and the top as protection against rain and wind. During the rainy season three sides of the hut are covered with palmyra leaves.

The most characteristic feature of the life of the Malapandaram is that they do not know how to cultivate the land and do not grow anything for subsistence. The Malapandarams depend entirely upon wild edible tubers and roots gathered from the jungle. They are habitually itinerary people and throughout the year they move from place to place, in every season in quest of forest produce. "Hunting is not practised even as a subsidiary vocation by the Malapandarams as they do not possess any weapons worth the name. They hunt in a most archaic foshion by sending tame dogs after small animals like rabbits, black monkeys, squirrels *etc.*"

The Paniyans and the Kurumbans are two jungle tribes of Malabar. The Paniyans have dark brown skin and possess long wavy to frizzly hair. Their stature is short, the average height of the male being 155.5 cm. The nose is short, and broad, the maximum breadth being nearly 85 per cent of the nasal height. The Paniyan men are good hunters and expert in the use of bow and arrow. They catch

fish by crude appliance and sometimes by poisoning the water with poisonous herbs. Both men and women work in the fields. The soil and climate are suitable for the cultivation of paddy in wet lands, ragi, tapioca, coffee, tea and pepper.

In Malabar (now in Kerala), there are actually three tribes all of whom are called Kurumbans. They are the Bet-Kurumbans, the Jen-Kurumbans and the Mullu-Kurumbans. The primary occupation of the Bet-Kurumbans is agriculture, that of the Jen-Kurumbans collection of honey which is their chief article of food and that of the Mullu-Kurumbans hunting with bow and arrow.

The Reddis inhabiting the mountain tracts between the Godavari and the Penganga in North Western Andhra Pradesh have developed a type of social organization with many unique features. According to C. Von Furer Haimendorf, "In physical type the Reddis are decidedly more primitive than the Koyas and it appears that the basic racial element is of Veddid affinities. The dark skinned and curly haired type dominant amongst the Chenchus, in which there is probably a Malid strain, is also represented, but besides these primitive tribes there are numerous individuals with more progressive features and it seems indeed that the Reddis are by no means a racially homogeneous population".

There are various occupations followed by the food-gathering tribes, such as, gathering of honey, collection of fruits, berries and tubers. In this group the principal aboriginal tribes are the following. The Muthuvan and Kanikar of Kerala, the Chenchus of the Nallaimallais, Kadar, Malasar, Irula *etc.*, of Wynaad, and stretching almost to Cape-Comorin along the ranges of Cochin and Travancore *etc.* The Dravidian peculiarities being more strongly developed in them.

The food-gathering economy of Southern India gave place to the agriculture. Leaving aside the tribes living in Nilgiris, the other tribal people sustain on fruits, berries, tuber and wild roots *etc.*

The principal aborigines of the Nilgiri hills are : Todas, Badagas, Kotas, Kurumbas and Irulas. The Todas are a purely pastoral people. They have large herds of buffaloes and depend for their support on their produce, with the addition of the "Gudu" (annual gift of grain), which they levy in kind from Badagas and Kotas. The Todas live in villages called mands. Each mand or hamlet, usually comprises about five buildings or huts, three of which are used as dwellings, one as a dairy, and the other for sheltering the calves at night. Each mand has its acknowledged pasture ground, which is not encroached upon by other.

The Badagas of Nilgiris are not a nomadic people, but possess large huts, thatched with very large leaves indigenous to their hills, and sides covered with logs of bamboo and [illegible].

The Kotas inhabit the Nilgiris and the mountain range which extends thence south-west into Kerala. The entire population may con-

veniently be classed as agriculturists. Both men and women participate in agricultural operations.

The other important tribes belonging to this group are Kadars and Malaialis. The Kadars inhabit the Anaimalai Hills and mountain range, which extends thence southward into Cochin. In physical features according to Dr. Guha, the Kadars show some resemblance to the Negritos and the Australoids. The Malaialis are a less known tribe of Shevaroy hills and unlike the other aboriginal tribes, they still adhere to the nomadic life of their forefathers. A large percentage of labourer; in the coffee gardens of Madras and Kerala are men and women belonging to the Malaiali tribes. Agriculture is the source of livelihood.

The Gonds are amongst the most civilized and advanced aboriginal tribes of India. The present habitat is confined in the Satpura plateau, Bastar, a portion of Nagpur plateau and the valley of river Narmada in Southern India. This part is the original habitat of the Gonds, although by now have these settled in other parts of Southern India. The land of Gonds is known as Gondwana.

The Gonds do not like to build their houses near the cross-roads as they are most conservative and like to remain aloof from the outer world and maintain their old ways of life.

The climate of the Gond country is mainly sub-tropical in general and varies in particular, as the Tropic of cancer passes through the region. The temperatures are greatly modified by the local hills and plateaus with average of 70 degrees F. Agriculture is very difficult in these hilly tracts. The little cultivation that is carried on is by forming terraces of the slopes of the plateau. The higher terraces grow barley, millet and corn; rice and wheat are grown on the lower slopes.

Besides agriculture the Gonds also practise hunting. Their main hunting arms are the arrow and the bow. The arrows are generally impregnated with deadly poison which they extract from a certain root black in colour. The fields of the Gonds in the forests are fenced from all sides in order to prevent the wild animals from entering the fields and destroying standing crops.

As is generally the system amongst tribal people, Gonds also maintain youth houses or Gotul, where the bachelors of the village both boys and girls, sleep in separate apartments at night. The Gonds strictly observe exogamy. Cross cousin marriage is generally practised. Such marriage is termed as "Dudh-lautawa". It saves the excessive bride price. Polygamy is widely prevalent amongst them.

The Chenchus of Nallaimallais and Hyderabad sides of Krishna river are one of the greatest food-gathering tribes. The people living on wild fruits, and tubers *etc.*, also sometimes chase wild animals for their flesh. Their main hunting arms are the arrow and the bow. They eke out their livelihood with great difficulty. The only source

of eking out their livelihood is fishing and hunting, and occasionally cultivating small patches of fields with millets as the main crop.

The Koya tribe lives in the Andhra Pradesh side of Koya area and southern most branch of Godavari river and the adjoining districts of Madhya Pradesh. They are patriarchal tribes; and divided into many clans. The tribe is divided into several occupational sub-tribes such as black-smiths, carpenters, brass-workers, and basket makers.

The Gadabas are mostly confined in Jaipur, Koraput and Makangiri areas. Physically they are short to medium in stature, deep chocolate to brown or nearly dark brown in colour, the face is short and projected forehead. The Gadabas are farmers, but there again fishing is an occupation often combined with agriculture. The Gadabas are expert in weaving and spinning.

The Baigas of Madhya Pradesh are very fond of the flesh of animals such as pigs, stags, *etc.* During festivals and other auspicious occasions, both men and women participate in their folk dance and enjoy it very much by singing.

The aboriginal tribes of Orissa live in economic stages ranging from hunting and food-gathering through shifting cultivation to settled plough cultivation. The Birhor, Koma and Kutiakandh depend on hunting for their livelihood. The Juang, Bhuiyan and Kandh are shifting cultivators.

The Kharwars and Korwas are two jungle tribes of Chhota Nagpur plateau. They are very hard working people. Korwas and Kharwars depend on hunting for their livelihood.

The Cheros are a plough cultivator tribe in Mirzapur where their number, according to the census of 1931, was only 4000. The 1941 census put their number at 2000. Many of them are employed in the iron and manganese mines of Keonjhar and Mayurbhanj.

The Santhals are a very large tribe, one of the largest in India, now approaching the three million mark and they are scattered over a wide area of Chhota Nagpur plateau, with a special concentration in Santhal Parganas. The Santhal and Oraon depend largely on permanent plough cultivation for a living. A large number of labourers in the tea gardens of Assam and North Bengal are Santhals and Oraons. Many Santhals, Oraons and others have been making a living by working in the iron and manganese mines of Singhbhum and Keonjhar. Rice and Millets are the crops they raise.

India's North East Frontier Agency is the home of serveal strata of tribal population largely of Indo-Mongoloid origin. Like the tribes in other parts of India, they are an economically backward people. But almost all tribes, whatever their main occupation may be, do some amount of hunting and food collecting unless forests have been

cleared away within a reasonable distance. The Nagas of Assam can be divided into the following sub-groups :—

(1) The Nagas of North Assam Hills, the prominent among them being the Rangapan and Konyak.

(2) Those inhabiting the western parts of Assam which contains the Rangma, Sema, and Angami Nagas.

(3) The Nagas of East comprising the Tankgkhul and Kalyaokengu.

(4) In the South, adjoining the Lushai and Kukis Hills of North Burma come the Kabui, *etc.*

(5) The Central region of the Assam Hills comprises the Yimstsungor, Phom, *etc.*

The Naga tribes of North East Frontier practise shifting agriculture. The similar practice of Jhuming is also found in their agriculture system.

The Naga economy is mainly dominated by bamboo, which is utilized in the construction of houses, arrows *etc.* Even the cooking utensils are made of bamboos. The chief means of their livelihood are hunting, fishing, honey gathering, basket making and agriculture.

Their houses consist mainly of grass and bamboo woods. The roofs are thatched with grass and the structure is built of the logs of bamboo.

The Khasis occupy a most charming country, enjoying a beautiful climate and a most fertile soil, well cultivated, drained and manured, the hill sides being covered with a succession of terraces of rich rice, with numerous villages in every direction. Some of them are so large that they might justly be called towns.

A woman is the head of the Khasi family. Marriage is a purely civil contract, and is usually arranged by the parents or agents of the parties.

The Abors are divided into exogamous clans and they are polygamous. The women amongst the Abors tattoo their chin and upper lips with vertical and parallel lines, and also make a vermillion mark on their forehead. Their staple crop is maize.

Mikirs were originally inhabiting the lower hills adjacent low lands of the central portion of the range stretching from the Garo to Patkoi hills. The Mishmi tribes live in the ranges between the Debang and Lohit rivers and settled also to some extent in the valley, where they practise jhuming agriculture.

The Khamtis are tribes of Shan descent, principally found around Sadiya Frontier Division. They are Budhists. Almost all the Khamtis live in villages built on mountain sides or spurs. Both men and women still retain their national costume, *viz.*, a blue cotton jacket and kilt of

chequered cloth for the former, and for the latter a blue cloth tied under the arms and reaching down nearly to the ankles, with a jacket above.

The Kukis are a Mongoloid tribe of Assam. Like many tribes of these parts, they are divided into various clans. The Kukis are mainly concentrated in the Lushai Hills, and also in northern Cachar hills. The Kukis provide most of their technological requirements from the bamboo forests.

The Garos like all other tribes of Assam practise shifting agriculture. Physically, Garos are connected with Mongoloids. Their main physical features are yellow skin colour, short to medium stature with flattened face and nose. The major portion of the Indian tribes are wholly dependent upon forest products. Cotton is available in large quantities in Garo hills, in Nowgaon and in Manipur. There the Garo tribes of Assam have specialised in cotton cloths and manufacture towels and specially bed-sheets *etc.* Basket making is another source of livelihood.

QUESTIONS

1. Analyse, in the light of modern knowledge, the origin and present distribution of the chief racial elements in the population of India.

2. "The problem of the aboriginals in India is a living one". Discuss the above statement and suggest suitable measures to improve their conditions socially, culturally, economically and politically.

CHAPTER 37

Regional Geographical Account of States of India

1. UTTAR PRADESH

		Cities	Population
Capital	Lucknow		
Area (Sq. kms.)	295500.4	Kanpur	971,962
Population	73,746,401	Lucknow	655,672
Females per 1,000 Males	909	Agra	508,680
		Varanasi	489,864
Literacy per 1,000	176	Allahabad	430,730
Principal Language	Hindi	Meerut	282,997
Density per sq. km.	324	Bareilly	272,808
Universities—		Moradabad	191,828
Allahabad, Agra, Aligarh, Varanaseya		Saharanpur	185,213
(Sanskrit), Varanasi (Hindu), Gorakhpur,		Aligarh	185,020
U.P. Agriculture (Pant Nagar, Nainital),		Gorakhpur	180,255
Meerut, Kanpur and Roorkee.		Jhansi	165,712
		Dehra Dun	156,341
		Rampur	135,407
		Mathura	125,258
		Shahjahanpur	117,702
		Mirzapur	100,097

Names of the eleven revenue divisions with districts comprising each :

Agra Division	Aligarh, Agra, Mainpuri, Etah, Mathura.
Allahabad Division	Farukhabad (Fatehgarh), Etawah, Kanpur, Fatehpur, Allahabad.
Faizabad Division	Faizabad, Gonda, Bahraich, Sultanpur, Pratapgarh, Barabanki.
Gorakhpur Division	Gorakhpur, Deoria, Basti, Azamgarh.
Jhansi Division	Jhansi, Jalaun (Orai), Hamirpur, Banda.
Kumaon Division	Naini Tal, Almora, Garhwal, Tehri Gharwal.
Lucknow Division	Lucknow, Unnao, Rae Bareli, Sitapur, Hardoi, Kheri (Lakhimpur).

Meerut Division	Dehra Dun, Saharanpur, Muzaffarnagar, Meerut, Bulandshahr.
Rohilkhand Division	Bareilly, Bijnor, Budaun, Moradabad, Rampur, Shahjahanpur, Pilibhit.
Uttarakhand Division	Uttarkashi, Chamoli, Pithoragarh.
Varanasi Division	Varanasi, Mirzapur, Jaunpur, Ballia, Ghazipur.

Uttar Pradesh is a frontier state along the foothills of the Himalayas, having common borders with Tibet and Nepal in the north, and is bounded by Bihar on the east, Himachal Pradesh, Haryana and Rajasthan on the west, and Madhya Pradesh on the south

The main physical features of the state are—

(1) The Montane tract or Himalaya west

(2) The sub-montane tract or Bhabar and Tarai

(3) The Gangetic Plain and

(4) The Trans-Jamuna Tract or Central Plateau

THE MONTANE TRACT

This is a large projection into the Himalayas on the north-west of the state and in fact includes the only portion of the Himalayas which lies actually within the northern border of the state. It stretches northwards from the densely wooded Siwalik hill to the barren region of perpetual snow, embracing the Uttarakhand, Kumaon division and Dehra Dun district of the state.

The Himalaya mountains consist of two ranges, the outer Himalayas and the inner Himalayas parallel to one another. The outer Himalayas are covered with forest and contain the Hill stations of Nainital, Ranikhet, Mussoori, Lansdowne and Chakrata. The inner Himalayas which are very high and covered with peaks of snow and contain snow-clad peaks of Nanda Devi (7817 metre), Kamet (7822 m.) Kedarnath (6714 m.), Gangotri (6614) Gaurishankar (7214) Trisul (7120 m) *etc.* The region is situated on very high level, the whole of it has cool summers and extremely cold winters. The Dehra-sub-montane area is the famous Dun, known as the garden of Uttar-Pradesh, lying between the Siwalik hills and Himalayas and partly on the lower slopes of both. It is healthy enough to have attracted a considerable colony of European pensioners.

The rainfall is very heavy in this region. It is densely covered with forest. The main occupation of the people, therefore, is lumbering and cattle and sheep-rearing. The higher mountains have the forests of deodar, chir or pine, oak, fir and spruce. On the lower hills are found sal, tun (cedrela toona) haldu (adina cordifolia) and khair acacia catechu) etc. Although the forests are dense and contain a variety of trees, as mentioned above, but they are of little commercial value at

present. They are too far away. It is difficult to bring the commodities from those distant regions to the centre or market and therefore impossible for them to be taken to the places where they can be sold on commercial basis. The costs of product and transport of timber or other forest products such as khair is so great that it does not pay to try and so the forests are left to themselves—except where they are to the plains.

Agriculture is most difficult in these parts. The little cultivation that is carried on is by forming terraces on the slopes of the mountains. Hence the system of cultivation is known as terrace cultivation. The higher terrace grow rice, wheat, barley and buck wheat; rice and maize are grown on the lower ones.

It is thinly populated and the population is mostly migratory. Cultivators descending from the hills to the Bhabar and entering the Tarai from the neighbouring plain districts, returning to their homes again after having cut their crops. The average density per square kilometre in this region is hundred. The peoples of this region speak different languages and the people of one village often speak quite a different language from those in the next within a short radius.

THE SUB-MONTANE REGION

This region is commonly known as Bhabar and Tarai. The Bhabar is a strip lying south of the foot-hills, largely covered with forests, still home of tigers and elephants. The hill streams which enter it sink and are lost, except in the rainy season. The Tarai is damp marshy strip south of the Bhabar where the streams from the hills reappear. It is covered for the most part with thick jungle and tall grass. The southern half of this division is very similar to the Gangetic plain.

The Bhabar and Tarai areas were till recently considered unfit for human habitation. They were full of marshes, bogs and primeval tropical forests in which wild beasts roamed freely. The unhealthiness of the tract and depredations of wild animals afforded little temptation to the people to settle in these areas permanently. In some cases some people did, however, live in isolated places. The population during the last fifty years was reduced by 25% to 40% while the population of the country as a whole had recorded an increase of about 35% within the same period. Life in the whole of sub-montane tract was one of continuous struggle for existence against wild animals, tarai vegetation, enervating climate, malignant malaria, bad drinking water, high death rate and infant mortality, low birth rate, appalling means of communications and lack of all amenities of life. An ever dwindling population here and there fought heroically against its extermination. But the entire picture has now changed. Where there was only a jungle in-

fested with wild animals, there is now a blooming garden, aptly called "Granary of Uttar Pradesh."

GANGETIC PLAIN

Bounded on the north by the sub-Himalayan belt and the south almost throughout by the Jamuna and after its confluence with the Ganges by the latter, lies the Gangetic plain, a vast level expanse of alluvial soil, extending right across the state, a distance of nearly 800 kilometres, with an average width of about 160 kilometres, densely populated, studded with many cities, and cultivated almostly continuously throughout. The whole of this land falling between Jamuna and Ganga is called Doab. The Doab itself forms the most fertile region of all. It can be divided into three sub-divisions—

(1) The Upper Doab
(2) The Middle Doab
(3) The Lower Doab

The Upper Doab is the richest. It lies stretched from Saharanpur to Aligarh. An admirable net-work of canals and consequently prosperous tracts of land overgrown with commercial and money crops, *viz.*, sugarcane, wheat and cotton are characteristic features of this subdivision.

The Middle Doab is less rich but still fertile and prosperous. The Lower Doab is the poorest part from Kanpur to Allahabad. The soil there is sandy and thin. Taken as a whole this tract is the real representative of the state. Agriculture has reached its zenith in this portion.

This tract is also by far the most thickly populated portion of the whole country. The population nowhere is less than 500 persons per square km. The average density in the west is 500 and in the east over 700 per square km.

The large number of people that live in this natural region are engaged in agriculture. They live in large and small villages scattered over the plains. The language of the people throughout this natural region is Hindustani, people being in this tract mostly Hindus. In the upper Ganga valley due to irrigation facilities much of the land is capable of producing two crops in the course of one year. Wheat is usually a winter crop. Other crops can be grown on the same land in the hot season and in the rains. Everywhere in this region wheat and sugarcane occupy larger area than rice. Some of the driest districts grow no rice at all. Another important food of the people dwelling in the dry regions of the upper Ganga valley is millet. It is a very important crop and is second in importance only to wheat. Other food crops include maize or corn, gram and pulses. The other important mo-

ney or cash crop in this region is sugarcane, cotton and oilseed. North of the Ganga, the irrigation entirely is done from wells and canals.

TRANS-JAMUNA TRACT

The trans-Jamuna tract, excluding the parts of the districts Agra, Mathura and Allahabad, referred to above is divided into two natural divisions. The western parts, comprising the four districts of the Jhansi division, with a total area of 27222.0 square kilometres, lies on the eastern slopes of the Central Indian Plateau, from which it derives its name.

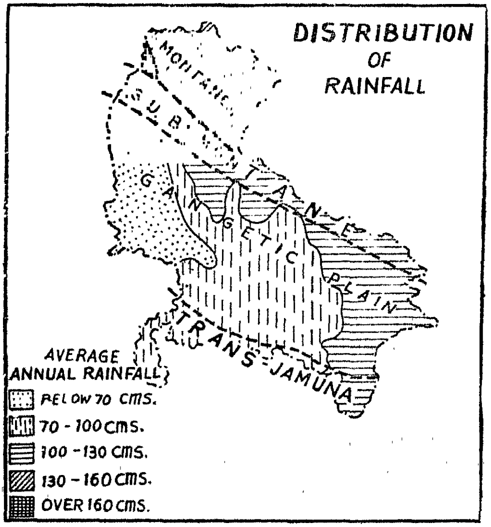


Fig. 71. Distribution of rainfall.

It is broken rocky outlying spurs of the Vindhyan hills covered with stunted trees and jungle. The soil is chiefly of the type known as black cotton soil and differs entirely from the alluvial soil of the Ganga plain. Fig. 71 shows the physiographic divisions and annual rainfall in Uttar Pradesh. The rainfall is greatest in the north and diminishes towards the south.

Irrigation and power

To meet the irrigation demand of the state, the Government had for years been anxiously exploring all the possible methods of augmenting the supplies of water of the rivers. Our state can broadly be divided into following geographical regions.

Western Region. Although a number of major irrigation works were constructed in this region, the demand of cultivators for water has constantly been increasing. For a time it was met by extending the channels and running the canals with increased load, then a stage was

reached when the main canals and their headworks could carry no more, their capacity being after all limited. It was, therefore, decided to remodel the upper Ganga, the eastern Yamuna and the Agra canals and their Deoband, Mat, Hathras and Fetehpur Sikri branches. Already 1400 tubewells have been constructed to irrigate 120,000 hectares of land.

Central Region. In 1948, the work of extending the Sarda canal system was started and since then over 3200 kilometres of channels have been added to it to irrigate an additional area of 193,200 hectares in Allahabad, Bara Banki, Hardoi, Kheri, Lucknow, Pilibhit, Pratapgarh, Rae Bareli, Shahjehanpur, Sitapur, Sultanpur and Unnao districts. In the areas which will still be beyond the command of canals, 600 tube-wells have been constructed.

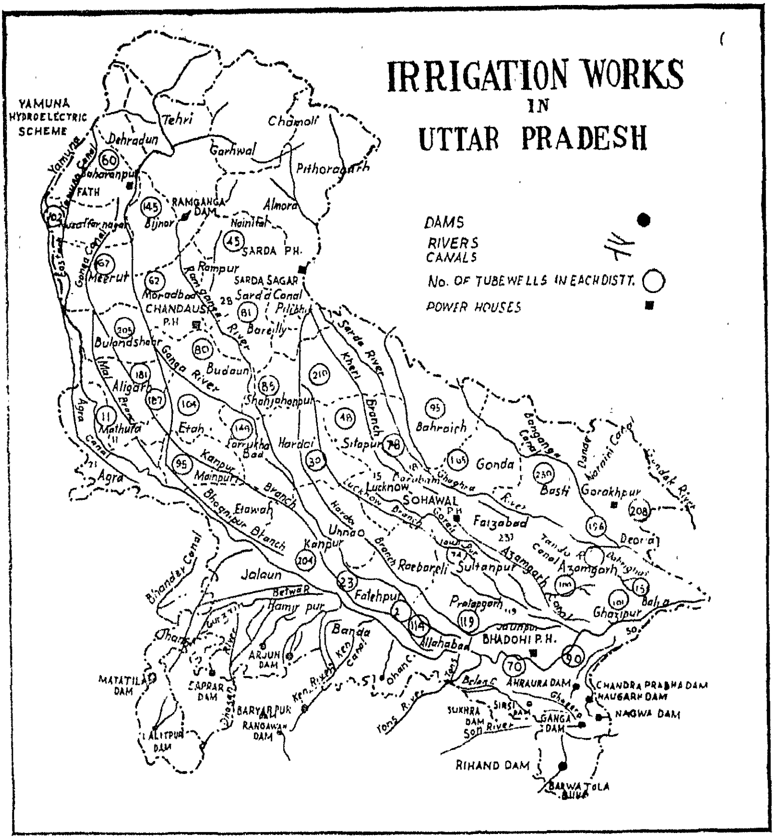


Fig. 72. Irrigation Works in Uttar Pradesh.

Bundelkhand and Baghelkhand Region. From the point of view of irrigation works the chief characteristics of this region are that it is hilly and rocky; and that its rivers, which rise in the Vindhyas are not snow-fed; they swell up to enormous proportions in the rainy season and dry up almost completely during the dry weather when irrigation is required most. The Betwa, the Ken, the Dhasan and the Ghagar Canals all take off from storage reservoirs. Other important irrigational works are Matatila Dam, Lalitpur or Govindsagar, Saprar Dam or Kamalasagar, Arjun Dam, Rangawan Dam, Ahraura Dam, Chandraprabha Dam, Naugarh Dam, *etc.* Fig. 73 shows the irrigation works in Uttar Pradesh.

Eastern Region. The regime of flow of water in the rivers in the eastern districts of Uttar Pradesh is moody in the extreme. Sometimes there are terrific floods, which completely wash away the standing crops grown on th usands of hectares of this exception lly fertile tract, and sometimes scorching droughts, which permit absolutely nothing to sprout. Agriculture, which is the chief industry of the people of the area has, therefore, been always insecure. To protect it, nothing was ever don till a few years back when a number of projects were drawn up to check floods and to provide irrigation facilities in this previously neglected territory. A number of irrigation works have also been completed or are nearing completion in this region. This include Banganga Canal Dohrighat pumped canal Tanda pumped canal, Narayani-Gandak Pokha Canal, Rihand project, Gandak project *etc.* Names of certain irrigation systems of U.P. are given below with the area irrigated in hectares by each :

Irrigation Schemes	Area Irrigated (hectares)
Upper Ganga Canal	687,260
Lower Ganga Canal	592,404
Eastern Yamuna Canal	189,340
Agra Canal	159,400
Betwa Canal	105,448
Ramganga Canal	6,689
Banganga Canal	5,827
Sarda Canal	592,506
Rohilkhand Canals	21,020
Ghagra Canals	21,020
Ken Canal	95,769
Canals in Tarai Division	14,613
Canals in Kumaon Division	8,840
Dhasan Canal	35,092

Belan Canal	25,970
Dohrighat	8,587
Chakia and Chandauli Canal	5,867
Rampur Canals	21,373
Dum Canals	11,018

The following are the names of power houses showing their location and installed capacity in Kw.

Power Houses	Location	Capacity (Kw.)
Palra Hydro.	Bulandshahr	600
Bhola Hydro.	Meerut	2,700
Nirgajni Hydro.	Muzaffarnagar	5,000
Chitaura Hydro.	,,	3,000
Salwa Hydro.	,,	3,000
Sumera Hydro	Aligarh	1,200
Mohammedpur Hydro.	Saharanpur	9,300
Pathri Hydro.	,,	20,400
Tehri Hydro.	Tehri	20
Khatima	Nainital	41,400
Bageswar	Almora	30
Chandausi (Thermal)	Moradabad	9,000
Harduaganj (,,)	Aligarh	20,000
Sohwal Thermal	Faizabad	19,500
Mainpuri Thermal	Mainpuri	10,000
Rampur Thermal	Rampur	3,000
Mau Thermal	Azamgarh	15,000
Gorakhpur Thermal	Gorakhpur	15,000
Moradabad Diesel	Moradabad	650
Aligarh Diesel	Aligarh	400
Tundla Diesel	Agra	200
Laksar Diesel	Saharanpur	50
Meerut Diesel	Meerut	250
Saharanpur Diesel	Saharanpur	250
Bahraich Diesel	Bahraich	3,136
Dhakrani Diesel	Dehra Dun	1,400
Pauri (Garhwal)	Garhwal	162

Siswa Bazar	Gorakhpur	127
Hamirpur Diesel	Hamirpur	211
Mahoba Diesel	,,	331
Chamoli Hydro.	Chamoli	20

Mainly an agricultural region, as other states in India are, the pressure of population on land in Uttar Pradesh is immense, per capita land coming to about .460 hectare as against the all India average of about .900 hectare. The state stands first in its area under wheat, maize, barley, gram, sugarcane and sesamum; second in bajra, linseed, rape and mustard, besides producing considerable amount of rice, jowar and small quantities of ragi or "makra" cotton, groundnut, tea and tobacco.

Wheat is mostly grown in the Doab region of Uttar Pradesh. Ghazipur, Ballia, Deoria, Basti, Gorakhpur, Faizabad, Kheri, Bahraich, Shahjahanpur, Pilibhit and Bhabar and Tarai regions are famous for rice. Sugarcane is mostly grown in Badau, Gorakhpur, Gonda, Shahjahanpur, Pilibhit, Muzaffarnagar, Saharanpur, Bulandshahr and Meerut etc. Kumaon Hills are famous for fruits. It is the only opium-producing state in the Union. Tobacco is mostly grown in Saharanpur, Meerut, Mainpuri, Bulandshahr, Varanasi and Farukhabad. Fig. 73 shows the distribution of crops in Uttar Pradesh. A recent survey conducted by the State Directorate of Geology and Mining has confirmed the belief that U.P. has got vast mineral potentialities in addition to the existing mineral resources which alone are sufficient to sustain several important industries for several decades. The existence of extensive limestone fields in Dehra Dun, Garhwal and Mirzapur adjacent to the site of the State Cement Factory points to a very bright future for cement industry in the state. Besides some very important and valuable minerals such as asbestos, aluminium silicates known as clays, copper, gypsum, lead, soapstone, sulphur and pyrites, etc., have been found to occur in abundant quantities in various regions of Garhwal, Tehri, Chamoli, Pithor garh, Almora and Naini Tal.

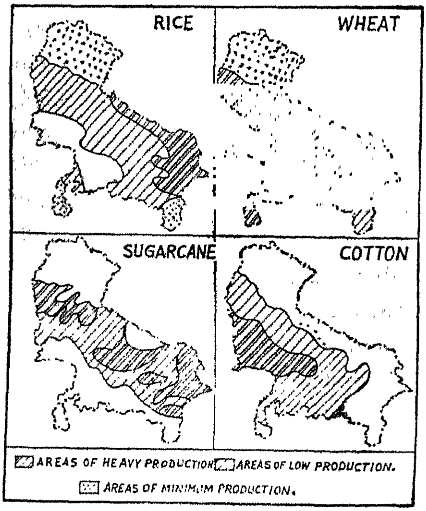


Fig. 73. Distribution of important crops.

Industries

Much has been done in the field of industrial development in the state since the advent of independence. The establishment of a cement factory at Churk in Mirzapur with a productive capacity of about 1400 tons of cement per day and a precision instruments factory at Lucknow which produced 36000 water meters and 300 microscopes per year, constitutes an important step towards the state's industrialization.

Large Scale Industries

Important large scale industries in the State are textile (cotton, woollen and jute), Sugar, Power-Alcohol, Glass, Leather and Tanning, Oils Vanaspati, Rosin and Turpentine, paper and paper board, Hosiery, Match and Cement.

Sugar Industry. Well over 50 per cent of the total white sugar produced in India is produced in the Uttar Pradesh. The obvious reason is that about 55 per cent of the working sugar factories are situated in the state. It is somewhat intriguing to find that though U.P. lies in the sub-tropics and does not enjoy climatic advantage for cane-growing (sugarcane being a tropical plant) yet the largest number of factories (68) are concentrated in this area. The concentration is mostly in the eastern districts of Gonda, Gorakhpur and Deoria and in the western districts of Moradabad, Saharanpur, Meerut and Muzaffarnagar.

Glass Industry. There are about 25 general glass factories in the State. These factories manufucture different varieties of glass articles. The glass industry is an important industry at Bahjoi, Balawali, Sasni, Harangau, Shikohabad, Naini, Ghaziabad and Varanasi. Firozabad is the chief centre of manufacturing glass bangles in India. At Firozabad in Agra district, there are 88 glass bangle factories manufacturing bangles.

Cotton Textile Industry. Kanpur is the chief centre for cotton spinning and weaving mills. Sahjanawa is next to it in importance. According to the latest figures available about 600 persons are employed in registered cotton ginoing and baling factories and about 58,000 in spinning and weaving mills.

Leather Industry. Agra is the chief centre of shoemaking. Kanpur is next to it in importance. There are over 100 tanning centres and three training centres in the State for the development of tanning industry.

Heavy Electrical Equipment Plant, Ranipur. Near Hardwar U.P.—is being set up with Soviet assistance, and is designed to manufacture steam turbines and generators, water turbines and generators, medium and large-sized industrial electric motors. On completion, it will be the biggest of its kind in the world.

Diesel Locomotive Works. The factory, located at Varanasi, was opened in 1962. The first loco was commissioned in 1964, upto the

end of 1965, 12 locos were assembled from imported components and 37 manufactured in the factory.

Hindustan Aircraft Ltd. The Government of India Aircraft Plant now known as Hindustan Air-Craft Ltd., is located in Kanpur. The company is managed by a Board of Directors under the Ministry of Defence through a Board of Management.

The Sports Goods. The sports goods industry in the State is mainly concentrated in Meerut.

Other Industries. Main cottage industries in the State : locks, brass and copper (utensils), cutlery and building fittings, wood working, basketry essential oils and perfumery *etc.*

Small scale Industries in the State : Oil-engines, Cane crushers, Wood screws, Wire nails, Cycle industry, Paints and Varnishes, Steel furniture, Drilling machines, Baby boilers, *etc.*

Oil Engines. A number of units have sprung up in Ghaziabad and Kanpur. In Ghaziabad alone there are 15 manufacturers producing about 125 engines up to 40 to 44 h.p. per month. These are being exported to Afghanistan, West Asian countries, Burma, Ceylon *etc.*

Oil Expellers. Oil expellers are also being produced chiefly in Ghaziabad and Kanpur. In Ghaziabad there are six firms manuafacturing about 120 oil expellers per month, each costing about Rs. 2,000 on an average. In Kanpur one firm, *viz.*, M/s S. P. Engineering Corporation, manufactures oil expellers besides, filter-presses and other oil mill parts.

These are also exported to Ceylon, Africa, East Pakistan, Afghanistan, *etc.*

Baby Boilers. Boilers up to the capacity of 100 lb. pressure are being manufactured at Ghaziabad, Kanpur, *etc.*

Cane Crushers. Cane crushers are manufactured chiefly in Meerut. One firm, *viz.*, M/s. Meerut Engineering Works, produces 10 cane crushers up to the value of Rs. 30,000 per month. The same firm is also engaged in the manufacture of sugar centrifugal machines.

Railway Equipments. M/s. Singh Engineerng Works, Kanpur, manufacture railway tract fittings, two-way keys, cotters tie bars, joys. They also process scrap into finished steel. Steel cast iron sleepers manufactured by them are used by various railways throughout the country. Railway sleepers are also manufactured in Aligarh, Meerut, *etc.*

Drilling Machines. Two firms, *viz.*, M/s. Narayan Engineering Works, Varansai and M/s Singhal Engineering Works, Aligarh, have started manufacturing drilling machines, which are precision instruments.

Steel Furniture. Steel furnitures, fire-proof safes, cabinets and steel beds are also being manufactured in places like Kanpur, Meerut,

Allahabad, Ghaziabad, *etc.* These are sent out all over the country. Some of the firms are also manufacturing collapsible gates.

Tractor Equipments, Shares, Harrow and Plough Discs. This iodustry has been recently developed in the state. One firm in Meerut is engaged in the manufacture of tractor-drawn implements and the accessories as well as animal dr v n implements and pneumatic tyre for bullock carts. Harrows are also manufactured in Ghaziabad.

Cycle Industry. Though of recent origin, this industry has become one of the most well-established industries of the State. The importat centres are Kanpur, Lucknow, Varanasi, Ghaziabad, Rampur and Allahabad. About 1,50,000 cycles are assembled by the various

Fig. 74. U. P. Industrial Centres

units, besides manufacturing various cycle and rickshaw parts. Besides meeting the internal requirement these are exported to foreign countries.

Paints and Varnishes. This industry is localized at Kanpur, Meerut, Bareilly and Lucknow. There are over a dozen medium and small scale factories with a total production capacity of 5,500 tons of paints and enamels and 600,000 gallons of varnishes. Fig. 74 shows the important industries in Uttar Pradesh.

Carpet Making. Carpets at present are manufactured in Shahjahanpur, Agra, Sitapur, Bareilly and Bhadoi.

Lock Industry. Locks are chiefly manufactured in Aligrah. There are about 340 small units engaged in the industry employing about 20,000 persons in Aligarh proper. Click locks are also being manufactured at Govindpuri, 100 operations are required to make this particular lock.

Population

The population is thickly massed in the Ganga plain, where the density rises in the eastern div'sion to 900 per square mile, the Go-

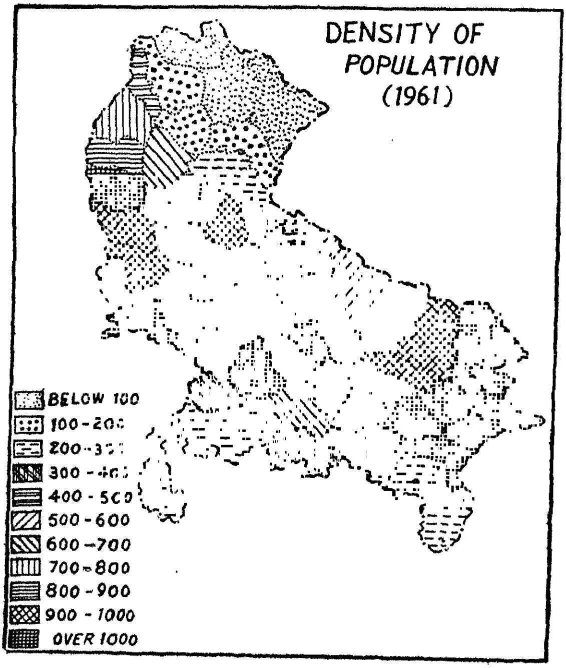


Fig. 75. Population Density.

rakhpur district having a density of 1052 persons per square mile. The density of persons per square mile for the State as a whole is 649, the district of highest density being Lucknow (1370) and of lowest density Uttar Kashi 41. Climate has much to do with the density of population. Two districts in U.P., Pithoragarh and Chamoli, have over 6000 square miles, a larger area than Mirzapur, and only 526716 people. The Kumaon Division of U.P. may comprise about 9199 square miles with 2037790 people. In still another place, one may note sparse population. In the trans-Jamuna tract population density is less than 200 people per square mile. In India the Ganga plain is one of the most densely populated lands. In the Ganga Valley the eastern districts of the state and the neighbouring districts have areas of high density. See map 75.

The density of population in the State is 649 to a square mile, the population is almost entirely agricultural and it needs no argument to show that unless some radical and hitherto undreamt of change is introduced into the system of agriculture the soil cannot bear a greater pressure of population than it is doing at present. The agricultural statistics published by the State Government has shown that the cultivated area has increased and that the scarcity of pasturage for the cattle has become a menace. In sub-montane region of Uttar Pradesh the case is different. The standard of cultivation is not so high as it is in the Ganga plain and in many parts cultivators are in possession of more land than they can cultivate. There is ample room for the expansion of cultivation in Bhabar and Tarai. In Eastern and Central zone of Uttar Pradesh where the density of population is already greater it has been more nearly stationary. The cultivation of rice which predominates in south eastern U.P. is more remunerative and capable of supporting a dense population Here it is impossible to expect a considerable expansion of cultivation or of population. A tenth part only of these districts is uncultivated. Nearly half of this is devoted to mango groves which are valuable for food, timber and fuel, the remainder barely suffices for pasturage of cattle. In these circumstances it is impossible to suppose that an increase of population is either likely or desirable.

2. PUNJAB

Capital	Chandigarh	Principal Language	Punjabi
Area (Sq. m.)	21630	Density (per sq. m.)	572
Population	11,400,000	Literacy per 100	271

Universities—

Punjab (Chandigarh), Punjabi (Patiala), Agricultural University (Ludhiana).

Punjab, a state of northern region of the Indian Union, is bounded on the north by the Ravi, which separates it from Jammu and Kashmir;

on the north east by the Union territory of Himachal Pradesh, on the west for a short distance by Ravi and West Pakistan, on the south by Rajasthan and on the south east by the newly created Haryana State. The state lies between north latitude 27°-55′ and 32°-55′ and east longitude 73°-50′- and 78°-50′, with an area of 21630 square miles.

Physical Division. The main physical features of the state are—

(1) The montane tract or Himalaya west.

(2) The Plain.

The general appearance of the state to the north is that of a plain with a few isolated rocky hills. Further south, beyond a line drawn from north to east (See fig. 76) a little to the north of Hoshiarpur, the hills increase in number and size, and the country becomes more undulating and broken up by ravines and *nalas*. The hills in the north east of the state are low and isolated, but to the north of Nangal they are found in small groups, or in long narrow continuous chains parallel to each other from north-east to south-west. The parallel chains are met with at intervals only in the north eastern parts of the state. The ridges are generally bare and sharp, and their slopes are covered with thick scrubby jungle, and sometimes near their bases with trees of considerable sizes. Extensive forests of pinus longifolia (chir) cover the northern slopes.

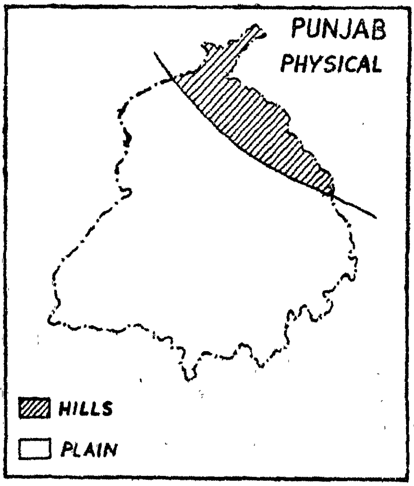


Fig. 76. Physical Divisions of Punjab

The "Punjab" means *Panchnad* or land of five rivers—*i.e.*, Sutlej, Beas, Ravi, Chenab and Jhelum; but the plainwasconsidered to include all the land between the salt range on the north, the ranges which border Afghanistan on the west, and the wall cliffs which flank the desert plateau on the southwest. The northern portion of this area, which corresponds roughly with the north plateau of the Punjab, has a more diversified surface than the southern. It now forms part of West Pakistan.

The Southern Punjab is composed mainly of clay. It is a flat-floored area, which has been covered in the course of ages with soft, fertile soil brought down by the Sutlej and its tributaries.

The climate of the Punjab is dry and tolerably healthy except during autumn, when rich vegetation causes malaria, at the com-

mencement and close of the rains, when moisture first loosens the earth and it begins to dry up. The heat is great during the hot season which is perhaps to be attributed to the absence of trees and the radiation from the bare surface and barren plains with which the state abounds. The average rainfall is about 400 millimetres. The southwestern districts and plains have a smaller rainfall than the remainder of the state. The following table shows the monthly rainfall and number of rainy days in one of the principal stations of the Punjab.

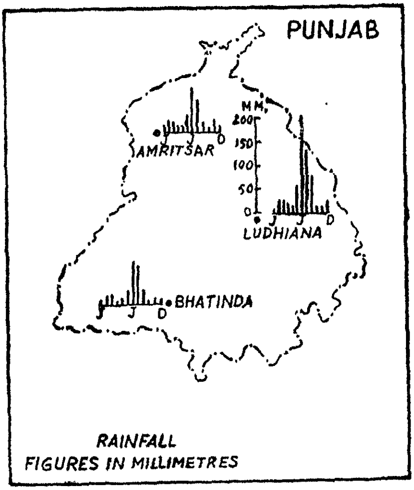


Fig. 77. Monthly rainfall in some important stations.

Monthly Rainfall (Millimetres) and normal monthly climatic data of temperature in °C.

Ludhiana

Month	Max. Temp.	Min. Temp.	Rainfall	No. of rainy days
Jan.	19.4	6.5	38.3	2.7
Feb.	21.8	8.6	34.3	2.7
Mar.	28.4	13.5	23.9	1.8
April	35.4	19.2	16.5	1.3
May	40.1	24.3	13.5	1.5
June	40.4	27.2	57.9	3.5
July	36.3	26.8	205.0	8.4
Aug.	34.9	26.2	168.9	7.3
Sept.	34.9	23.8	100.3	3.8
Oct.	33.5	17.2	10.9	0.7
Nov.	27.4	10.6	10.9	0.4
Dec.	21.6	6.8	18.3	1.4
Total	31.2	17.6	691	35.5

Fig. 77 shows the monthly rainfall in some of the important stations of the state.

Irrigation. The climate is so dry in summer that cultivation depends largely on irrigation, but where this is available the yield is good. The tributaries of Sutlej, which are kept supplied with water by the Himalayan snows, are, therefore, of great value in irrigation. It is well-fed by canals. Sixty five per cent of the total cropped area in the state is irrigated. The following table shows the principal irrigation works in the Punjab.

Principal Irrigation Works in Punjab

Upper Bari Doab Canal	335.17000	hectares
Sirhind Canal	600.17000	,,
Nangal Barrage	1112.92000	,,
Dadri	..	

Power. The main sources of electric supply in the state are :

(1) Uhl river Hydro-electic scheme at Joginder Nagar where four sets of 12,000 kw. each, including one stand-by, are installed,

(2) The Nangal Power house I at Ganguwal with 3 units of 24000 kw. each. All the three are working.

(3) The Nangal Power House II at Kotla with 3 units of 24,000 kw. each, Aall the three are working.

(4) Bhakra Dam—Left Bank Power House with six generating Units of 90,000 kw. each and

(5) Bhakra Dam—Right Bank Power House with five generating units of 90,000 kw. each.

Agriculture. The mode of husbandry in this state differs so little in any important respect from that practised in the other states of the Union, that it would be useless repetition to describe it here.

The facts relating to the practice of agriculture given under Uttar Pradesh will hold equally good for Punjab. I will therefore confine myself to a general view of the present state of the State, its cultivation, amount and value of produce, irrigation, and the few peculiar agricultural products worthy of notice. The great extent of which, cultivation had already been carried, left comparatively little room for the increase which steadily advancing prices and the introduction of canal irrigation would have led us to expect. Still the change, such as it is, has everywhere been on the side of increase. The area under grass for pasturage is very restricted, so much so, that in several districts, as Amritsar, where cultivation is 90 per cent and Ferozepore, where it is 85 per cent of the total area, the rabi, which is specially useful for growing crops, has had to be increased at the expense of superior produce of the *Kharif*. As a general rule, the more extensive the rabi the richer and more productive the crop, and here only in exceptional cases does the *Kharif* in any way exceed the *rabi*. The few wide uncultivated pasture

lands in Kangra and hills of Gurdaspur must sooner or later come under the plough, and in a very short time cultivation must reach its maximum in this district. Great fertility is the characteristic of the state. Though only a portion of the total area is sown with *rabi* crops, a considerable portion of the *Kharif* is also resown, so that the intervals of unoccupied ground are scarcely seen. Nearly all the lands yield two crops in the year, the *Kharif* and *rabi* crop being taken according to circumstances. The principal crops are wheat, barley, gram, cotton and sugarcane. Within the last ten years the quality of both cotton and sugarcane has improved, whilst that of the other kinds of agricultural produce has remained stationary.

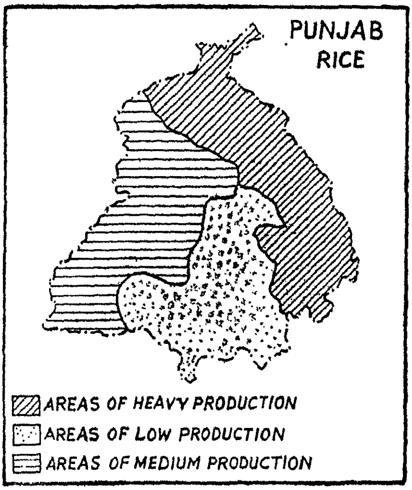


Fig. 78. Areas of Production

The crops usually grown are :—

Wheat, Barley (Spring). Wheat is mostly grown in Amritsar, Ferozepore, Jullundur, Ludhiana *etc.* (See fig. 79). Gram is mostly grown in the sandy clay soil of Ludhiana and Ferozepore districts of the Punjab. Barley is important in Kangra and Hoshiarpure.

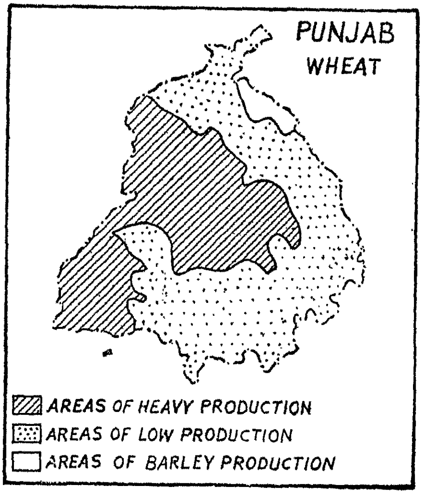


Fig. 79. Wheat fields

Rice (autumn). Rice is mostly grown in Kangra, Hoshiarpore and Hill region of Gurdaspur. (Fig. 78). The quantity of cotton grown is very large, the produce being sufficient for the ordinary requirements of the inhabitants, and it is frequently exported. (See fig. 80). Bhatinda and Ferozepore are famous cotton producing areas.

Sugar-cane is grown in Amritsar, Jullundur, Ludhiana and

Ferozepore districts of the Punjab. Millets are also grown in various districts. There is a small export trade in oil seeds. Kangra Valley is famous for green tea. Apple, pears and walnuts are also grown to a considerable extent throughout the Kangra district. Vegetables and tobacco are also grown all over the state.

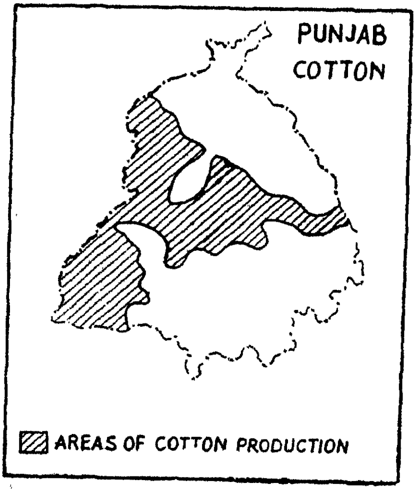


Fig. 80. Cotton Areas

Industries

The industrial history of the Punjab is of recent origin. The state has always been an agricultural state. The idea of giving an industrial bias to the agricultural economy of the state took shape only after partition.

The industrial position of the Punjab, however, is much below the advanced states like Maharashtra, West Bengal and Madras. The number of people employed in the state per 1000 of the population is 4.8 as against the all-India average of 7.36. The average for West Bengal and Maharashtra is 22.9 and 18.77 respectively.

The pattern of industries in the Punjab is similar to that of the country as a whole. Industries based on agriculture and livestock account for the major portion of industrial employment and output followed by engineering industries.

The new industries started during the last two decades, include units of light engineering aluminium castings, drilling machines, standard quality lathes, belt conveyors, grinding wheels and fractional wheels, manufacture of tissue paper, electric lighting apparatus, metallic measuring tapes, photo-flash bulbs, glass syringes, water meters, snap buttons, bullock shoe nails, textile machinery and electric meters.

Some more plants to manufacture scooters, card clothings, tyres, antibiotic products, paper and nylon are in the process of being set up. After partition the state Government took a commendable step in developing industrial areas at Ludhiana, Jullundur, Batala and Malerkotla.

Railway rolling Stock. The Northern Railway's workshops at Amritsar have also recently ventured into a new field—that of manufacture of wagons. The Amritsar workshops have undertaken to manufacture 500 box type open wagons for transport of coal and coke, the proto-types were turned out in March 1963 and the whole order was completed in 1964.

Automobiles. The number of large-scale factories which were started earlier and have since gone into production is also considerable. A few instances may be quoted here. A factory for the manufacture of automobile ancillaries set up at Bahadurgarh has since 1961 gone into full production.

Among the important small scale industries are units manufacturig bicycles, sewing machines, hosiery, sports goods, art silk weaving, brassware, scientific instruments, resin and turpentine.

Considerable progress has been achieved in the development of the textile industry on a small scale basis. Perhaps the Punjab specialises in this field. There are at present 900 such units and their annual output is valued at Rs. 14 crores. The industry provides employment to about 11,500 workers.

Agricultural Implements. Units for the manufacture of machine tools and agricultural implements total more than 430. Batala is famous for manufacture of agricultural implements. The second important centre is Ludhiana and third is Jullundur.

Sports Goods. This industry, after it was uprooted from Sialkot on account of partition rehabilitated itself at Jullundur. This, like many other industries, is earning foreign exchange for the country.

Hosiery Goods. The hosiery industry has 920 units. The industry produced goods worth Rs. 4.25 crores during the year 1960. It employed about 8200 workers directly besides about 20,000 indirectly. In the powerloom weaving sector, there are 320 units with about 3,500 workers. The number of woollen yarn spinning units has risen during the past five years and now Ludhiana ranks among the biggest yarn spinning centres in the country. The increase was due to the big demand for woollen yarn—about 30 lakh lbs. a year—by the woollen hosiery industry. Ludhiana is one of the biggest staple cloth manufacturing centres in the state.

Bicycle Industry. During the pre-war years, a few enterprising people in the Punjab began producing bicycle parts in small workshops. They used improvised machinery and tools and produced accessories in the best way they could. The war proved a blessing for this industry. Owing to the acute shortage that prevailed in the market; whatever was produced by these units was readily absorbed.

After partition these units rehabilitated themselves mainly around Ludhiana, Amritsar, Malerkotla, Jullundur and Rajpura. See fig. 81

Electric Fans. The first factory for the production of electric fans in the Punjab was started during the 3rd plan period. Amritsar, Patiala, and Moga are famous for the production of electric fans. The Punjab Government also established two electrical appliance centres at the above mentioned places.

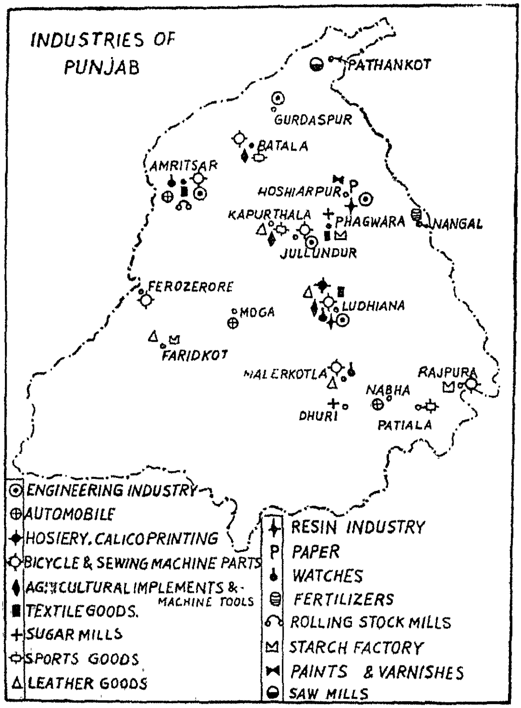


Fig. 81. Industrial Centres

Sewing Machines. A noteworthy feature of this industry is that all component parts are now made in the state. Ludhiana is famous for sewing machines. Malerkotla, Jullundur and Amritsar are famous for the production of sewing machines.

Rosin and Turpentine. The rosin and turpentine factory at Hoshiarpur manufactures rosin and turpentine on a large scale. Rosin and turpentine are important industrial chemicals obtained by steam distillation of gum-oleo-resin, and exude obtained from chir or pine trees and are consumed by various industries like soap, paper, paint, varnish etc.

Wood Working Industry. The wood working industry suffers generally because of unseasoned wood. In order to create a bias for seasoned wood among the artisans, Government established a wood seasoning plant at Pathankot.

Population. In the Punjab the greatest density is found in Jullundur and alongside the sub-montane tract, where rainfall is comparatively plentiful and the sub-soil water-level is high. Apart from this group of districts, which is situated in the most fertile portion of the state,

the density in the rest of the state depends largely on the variation in the irrigation facilities and agricultural resources, the relation between density and agricultural conditions being so drirectly proportionate as to indicate conclusively that there is in places pressure on the resources of the land. The beginnings of acute pressure are indeed observable in the north west of the state, where there has been a steady increase of population in Amritsar and Gurdaspur districts and a diminishing rate of increase in other districts, while, on the other hand, population is rapidly increasing in the irrigated portions of the state which have not yet received any check from economic causes.

The incidence of population per square mile in different areas of the Punjab varies very largely. The heaviest population per square mile is to be found in Jullundur with its large urban population and well irrigated tracts. Here we have 919 persons per square mile, whilst in Kangra and Bhatinda there are only 217 and 390 persons per square mile respectively. In the whole state density figures vary from 217 persons per square mile in Kangra to over 700 persons in Amritsar and Ludhiana districts of the Punjab. Fig. 82 shows the distribution of population in the Punjab.

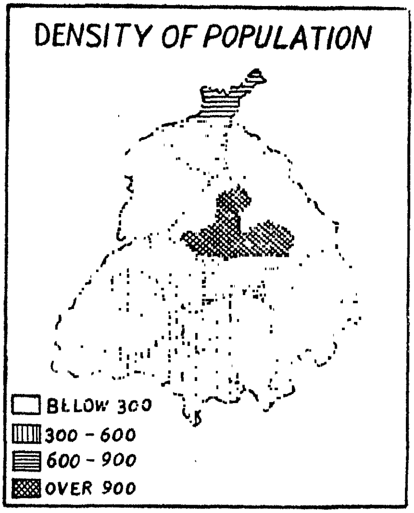


Fig. 82 Population Distribution

Among districts the highest density is found in Jullundur (919), Amritsar (776), Ludhiana (772), and the lowest in Kangra (217), Bhatinda (390), Patiala (464), and Sangrur (470). Hoshiarpur district has 558 persons per sq. mile. Ferozepur 417, Gurdaspur 726, Kapurthala 546.

In rural areas, the density is entirely dependent on the conditions of cultivation, which are themselves mainly determined by the two factors of rainfall and irrigation. The relation between these two factors may be expressed thus : Where rainfall is under 50 cms. per annum density on cultivation depends entirely on irrigation, where it is over 80 cms. entirely on rainfall; conversely where less than one-third of the cultivation is irrigated the incidence of population on cultivation depends on rainfall, where over two-thirds is irrigated irrigation is the determining factor. On the other hand the steady development of canal colonization caused a shifting of population from the congested tracts to the new canal areas.

3. HARYANA

Capital	Chandigarh
Area (Sq. m.)	16,670
Population	76,00,000
Density (per Sq. m.)	447
Literacy per 1,000	205
Principal language	Hindi.
Universities—	
Punjab (Chandigarh).	
Kurukshetra	

Haryana, the 17th state of the Indian Union, came into being on November 1, 1966 as a result of the reorganization of the existing state of Punjab on a linguistic basis.

Haryana, a state of the northern region of the Indian Union, is bounded on the north by Himachal Pradesh, on the north-west by Punjab, on the east by the river Jamuna, which separates it from Uttar Pradesh, and on the south west by Rajasthan. The State lies between north latitude 27°-40′ and 30° 45′, and east longitude 74° 35° and 77°40′ with an area of 16670 square miles (35.84% of the total area of the present Punjab) and a population of 76,00,000 (about 37% of the total population of the present Punjab).

Haryana is a Hindi speaking state with Hindi as its official language. As Hindi is also the national language, Haryana will have no difficulty in getting a due place in national life.

In view of the fact that for linguistic and development purposes, the state of Punjab was already divided into Hindi speaking and Punjabi speaking regions. The present reorganisation of Punjab implies, more or less, only a formal recognition of the existing realities. The regional formula, which was in force in the state, was intended to meet the demands of the people of respective regions for their due share in the economic development and also for proper safeguards for their language and culture.

Haryana structurally forms part of the Indo-Gangetic plain. It consists of districts of Hissar, Mohindragarh, Gurgaon, Rohtak and Karnal and parts of Sangrur and Ambala districts. The plains of the State are level, dry and culturable. They consist for the most part of alluvium soil.

Climate. The climate of Haryana varies very much. It is cold in winter. During the prevalence of the hot winds in the latter part of spring and beginning of summer the climate is dry, but when rains set in it is moist in the extreme. The following table gives the normal

monthly temperature (^{0}C.) and rainfall in millimetres, and number of rainy days of the important stations in the state :—

Months	Ambala				Hissar			
	Max. Temp.	Min. Temp.	Rain-fall	Days	Max. Temp.	Min. Temp.	Rain-fall	Days
Jan.	20.6	6.3	33.5	2.5	21.6	5.2	12.7	1.4
Feb.	22.8	8.8	47.5	3.1	24.6	8.4	13.7	1.2
March	29.1	13.6	23.9	1.8	31.0	13.8	16.3	1.5
April	35.6	19.1	16.3	1.6	36.6	19.8	6.6	0.5
May	39.9	24.3	18.5	1.5	40.7	24.4	13.7	1.4
June	39.8	27.1	77.2	4.4	40.9	27.9	32.0	2.9
July	35.3	26.2	244.1	10.6	37.6	27.3	108.7	6.0
Aug.	34.0	25.6	200.4	9.0	35.7	26.1	123.7	5.5
Sept.	34.4	23.3	129.8	4.7	35.9	23.6	71.4	3.1
Oct.	33.2	16.7	22.1	0.9	34.8	17.3	15.5	0.6
Nov.	27.8	9.9	4.8	0.4	29.1	9.9	1.5	0.2
Dec.	22.4	6.6	19.3	1.5	23.4	6.2	9.9	1.0

Fig. 83 shows the distribution of rainfall in Haryana State. The climate of Haryana is that of the Punjab in general. It is at one season tropical, at another partially temperate. The cold weather commences earlier and lasts longer than in the states further southeast, but the heat in March and April is considerable. Another peculiarity of the climate is, that although the severity of the hot season is, at its commencement, sometimes mitigated by local thunderstorms and showers, evidently due to the neighbourhood of Himachal Pradesh, the regular rains or summer monsoon are later in their arrival here than in Uttar Pradesh, and the rainfall is less. The minimum temperature recorded in the state is 7^{0}C in January, the maximum 41°C, as compared with 39.9 at Ambala and 40.9

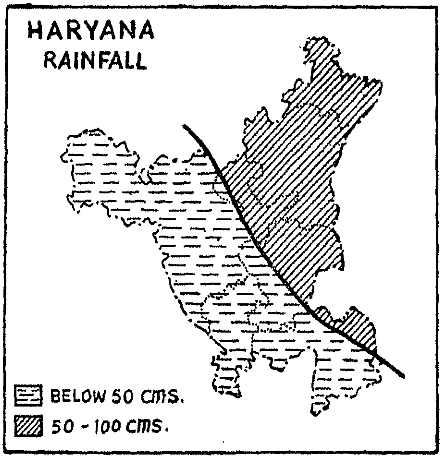


Fig. 83 Haryana Rainfall.

at Hissar. The mean temperature of the cold weather months, November, December, January and February, is 10°, 7°, 6° and 8°C. respectively. The temperature rises rapidly from the beginning of March, and by the end of June the maximum is attained. The rains usually set in towards the close of that month, and last till the middle of September, but they have been known to continue a month later. Irregularities in their occurrence are surely followed or accompanied by disease, generally in the form of fever.

Irrigation. 30 percent of the total cropped area in Haryana is Irrigated. The percentage of irrigation on the total cultivated area is 30, the highest rate being in Karnal and the next highest in Rohtak. The percentage is lowest in Mohindragarh, where most of the lands are sandy and well-sinking is a difficult operation. Though the three perennial rivers, the Ravi, the Beas and the Sutlej, flow through the new Punjab State, the canals they feed irrigate lands both in the Punjab and Haryana regions. The western Jamuna canal is exclusively within Haryana, as the Jamuna flows on the eastern side of the state. There is a greater scope for irrigation in the Haryana region. Vast sandy areas in the Gurgaon and Mohindragarh districts can bloom, once irrigation facilities are provided. While Haryana shall have its due share of the waters of the three western rivers, Ravi, Beas and Sutlej, an eventual solution of its irrigational needs can be found by building dams on the Jamuna and its tributaries so that water can be drawn in abundance in the western Jamuna canal system. One such dam site at Kasan, on the river Tons, a major tributary of the Jamuna, has already been investigated and it is proposed to construct a 231 metres high arch dam and a power station of 750 mwh. capacity near Kasan. Another site is at Kaunch 9 kilometres upstream of Tejewala headworks and at Chandi on the Jamuna. These dams will help irrigate large areas in both Gurgaon and Mohindragarh districts of Haryana State.

Agriculture. The total cultivated area in the state amounted to 109.33 lakh acres. The net area sown in Haryana is 85.65 lakh acres. Today, 86.82 lakh acres in Haryana are under foodgrains and 12.08 lakh acres under cash crops.

Wheat, gram and barley are the staple products of the *rabi* harvest, and the common millets and pulses of the Kharif harvest, cotton and rice are but little grown, but sugarcane and vegetables are more or less cultivated on irrigated land.

Wheat is usually sown in alluvium land, and on other soils when water is abundant. The sowing of wheat takes palce in the end of October and beginning of November; the crop is ready for the sickle in the end of March or beginning of April. In places where water is abundant, wheat is cut at the end of March. The wheat fields, where watering is necessary, are irrigated for the first time in the beginning of Dec-

ember, from three to seven times, according to the quality of the soil. Wheat is mostly grown in Ambala, Rohtak and Karnal districts.

Gram is sown at the same time as wheat land prepared in the same way. Rohtak, Karnal and Hissar districts are famous for growing gram.

Sugar-cane, where grown, is of superior kind, the juice is used for making sugar and *gur*. The area under sugarcane in Rohtak and Karnal districts is more than the area in any district of the Punjab.

Rice cultivation is chiefly confined to the north eastern portions of the state, but very little of it is grown.

Cotton is little cultivated. With water available from the Bhakra reservoir, cotton cultivation is extending fast in Hissar district.

Til is also sown during July-Aug. and cut during Oct.-Nov. It requires land of moderate quality. It is grown as much perhaps for home consumption as for export. The castor-plant is common all over the State. The districts of Gurgaon and Mohindragarh are known for rape and mustard. A recent survey has established the possibility of Jute cultivation in the swampy land in Gurgaon and Kaithal tehsil of Karnal. Fig. 84 shows the distribution of crops in Haryana state.

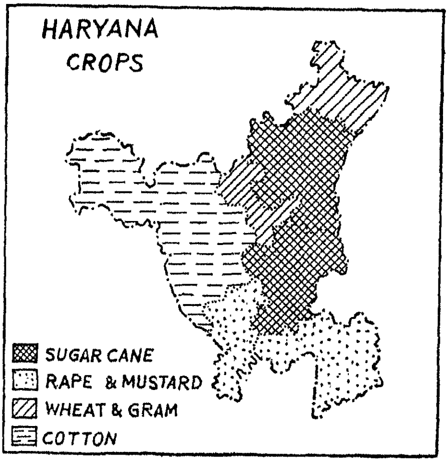


Fig. 84. Distribution of Crops

Animal Husbandry. Haryana and Shahiwal are the two famous breeds of cows found in the state. This breed is famous for its milk yield and thrives well on grazing. Of the domestic breeds of cattle the above mentioned Haryana breed are deservedly held in high esteem as best suited to the dry and raviny nature of the greater portion of the district. These are imported from the districts of Rohtak, Hissar, Gurgaon and Karnal. They are good both for agricultural purposes and for milk, and the Jats and Gujars earn a comfortable livelihood by breeding them and exporting ghi. The large bullocks of the Nagor and Hissar breed are, however, considered to be too large and too delicate for agricultural and draft purposes, however good they may be for the improvement of milch cattle.

Minerals and Industries. The basic factor responsible for industrial backwardness of the state is the lack of resources, both mineral as well

as forest. Haryana has iron and slate reserves in Mohindragrah district. Again forests cover only 10 percent of the total area. Even the available resources have not been utilized fully on account of other factors as lack of capital and lack of availability of minerals to set up industries.

There has been considerable progress recently in the development of new lines of manufacture in the state, for example, automobile parts, electrical goods, precision tools, radio components, chaff cutting blades, light steel structurals, rivets, haps, hinges and staples. Units for manufacturing transistor, radio, emery powder, glass mirror, pine oil, vacuum flasks, and glass syringes have already gone into production.

Haryana leads in cottage and small scale industries. If one visits Sonepat, Rohtak, Panipat and Yamunanagar, one is astonished at the industrial progress in the state, particularly in the small scale sector. In these towns, almost every alternate shop or house is a small workshop or a manufacturing unit.

A new industrial belt has recently been developed on Mathura Road beyond Badarpur in Gurgaon district of Haryana. The proximity of Delhi has induced many entrepreneurs to set up industries in this area. As many as over 100 important units are in the process of being established.

Rolling Stock Mills. The Northern Railway Workshops were started to manufacture a thousand B. G. four wheeler wagons at Jagadhri.

Paper Industry. Paper industry is mostly concentrated in Panipat, Jagadhri, Faridabad and Jamunanagar or Yamunanagar. The Yamunanagar mills have plans of expansion.

Cotton textile Industry. Considerable progress has been achieved in the development of the textile industry in the state. The industry is mostly concentrated at Hissar and Bhiwani. Bhiwani is one of the biggest cotton textile manufacturing centres in the State.

Bicycle Industry. The bicycle industry progressed rapidly and there are now many registered units in Haryana. The small scale units are producing almost all the parts required for the assembly of a bicycle, except chains, freewheels and B. B. Shells. The investment is not large and hence entrepreneurs with small investments are able to enter the industry. They cannot naturally afford to instal modern automatic machines or to engage highly qualified technicians. Hence there are chances of some of the units producing sub-standard goods. If these components find a way into the bicycle manufacturing units, it will naturally undermine the quality of bicycles.

The industry is concentrated around Sonepat, Faridabad etc.

Sugar Industry. The co-operative sugar mills, each costing around Rs. 108 lakhs, have been set up at Rohtak and Panipat. The mills have made steady progress. One of the important features of this industry is the organisation of co-operative sugar factories. The nation's biggest sugar mill with 3,250 tons capacity at Yamunanagar is also in Haryana.

Scientific Instruments. In the field of Scientific Instruments Industry, there have been several notable developments particularly in Ambala region.

X-Ray equipment industry is a development of recent origin. There is one X-Ray equipment factory at Faridabad in Haryana. This factory has been built, in accordance with the recommendation of a committee appointed by the Government in collaboration with Westinghouse, U.S.A. The factory is scheduled to produce X-Ray equipment to the tune of Rs. 50 lakhs a year. The factory will manufacture 100 percent of the X-Ray equipment including the winding of high-tension transformers, making of furniture parts of X-Ray equipment like tables, tubestands, controls, wires and inter connecting wires of the control board with various components. The factory will produce apparatuses of upto 500 Ma which is the most high powered equipment designed for medical purposes.

The demand for X-Ray equipment in the country is increasing and there is also scope for selling this equipment to veterinary hospitals. This factory has capacity not only to produce the X-Ray equipment to meet the country's needs but also to cater for markets in west and east Asia.

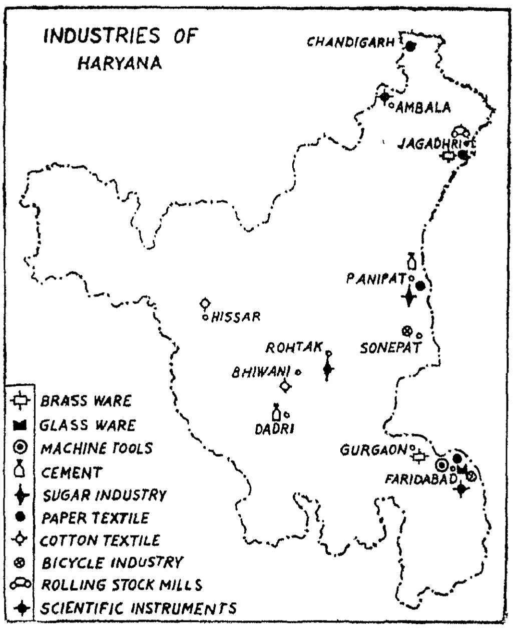


Fig. 85. Important Industries

Faridabad is progressively underaking the manufacture of tractors and agricultural emplements etc. The brassware industry in Jagadhari and Gurgaon, the cement factory in Dadri and glassware industry in Faridabad are also in Haryana State. Fig. 85 shows the important industries of Haryana state.

Population. Haryana is a state of diverse soils. It is particularly well Irrigated. Its crops vary with the soils, but generally speaking wheat, gram, sugarcane and cotton are its chief products. It has, however, a considerable urban population engaged in trade and industry and this has materially increased its density.

The district of Hissar is sparsely populated, but is different in many other respects. Hissar is a district of mixed soils, some far from valuable, with no large urban population of importance and many sands. Its density is 286 persons per sq. mile. Ambala's case is different. It has all the advantages of fertile soils growing valuable crops, such as wheat and gram, it is, however, well protected by canals and is well served by railways and roads. Its density is 644 persons per sq. mile and highest recorded in the state. The soils are good in Rohtak and well watered, growing valuable crops, there is little or no forest and the conditions approximate to those of the Ambala district. The district has a considerable urban population. The density of population in Rohtak is 610 persons per sq. mile that is the second highest recorded in the state. The district of Gurgaon is a land of mixed soils, some far from valuable, has, some urban population of importance and many swamps. The density of population is over 520 persons per square mile. The total geographical area of Karnal is about 3062 square miles with a population of 1,490,430 persons and the density of population is 487 per sons persquare mile. The chief features of this district are very great fertility, very great facilities for irrigation. There are few towns over 30,000 persons, notably Panipat (67,026) Karnal (72,109) and Kaithal (34,890). Fig. 86 shows the distribution of density in Haryana state. Mohindragarh is something of a puzzle, for it does not appear to be in any way subject to natural disadvantages sufficient to account for its low density. In Eastern portions of the district the soil is mostly good loam, there

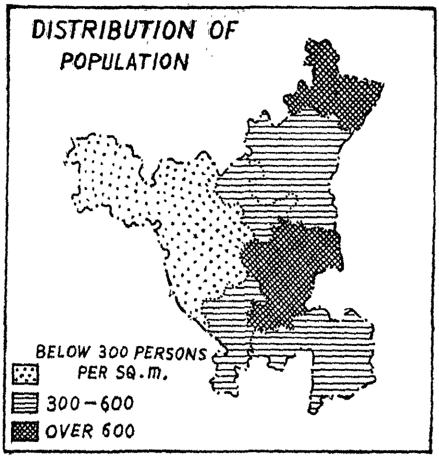


Fig. 86. Distribution of Population

is certainly a precarious sandy tract in western parts of the district, but it is not infertile in ordinary years. A possible cause may be that it possesses a comparatively low percentage of females : the figures in 1961 were 45 per 1000 males, as against 141 over the state. There are few towns over 9000 persons *i.e.*, Narnaul (23959), Charkhi Dadri (13,839) and Mahindragarh proper is only 9071 persons. Two towns namely Kanina and Ateli have 4582 and 1521 persons in all. The density of population of the district is 408 persons per square mile. There is a room for extension of cultivation in the sandy tracts of the state.

4. RAJASTHAN

		City	*Population*
Capital	Jaipur		
Area (Sq. m.)	132, 52	Jaipur	403,444
Population	20,155,602	A'mer	231,240
Density (per sq. m.)	153	Jodhpur	224,760
Females per 1000 males	908	Bikaner	150,634
Literacy per 1000	152	Kotah	120,345
Principal Languages Rajasthani		Udaipur	111,139
and Hindi		Alwar	72,707
Universities		Ganganagar	63,854
Rajasthan (Jaipur)		Beawar	53,931
Jodhpur		Sikar	50,636
Udaipur		Bharatpur	49,776
		Bhilwara	43,499
		Tonk	43,413
		Churu	41,727
		Pali	33,303

Rajasthan is divided into 26 districts, 82 sub-divisions and 212 Tehsils. The following names of the sub-divisions follow the names of the districts concerned. The names given in brackets are Headquarters of the sub-divisions.

Ajmer	Ajmer, Beawar, Kekri, Kishangarh.
Alwar	Alwar, Behror, Rajgarh (Alwar) Tijara (Kishangarh).
Bharatpur	Bayana, Bharatpur, Deeg, Dholpur.
Jaipur	Amber (Jaipur), Dausa, Jaipur, Kotputli, Sambhar.
Jhunjhunu	Jhunjhunu, Khetri, Newalgarh.

Sawai Modhopur	Gangapur, Hindaun, Karauli, Sawai Madhopur.
Sikar	Fatehpur, Neem-Ka Thana, Sikar.
Tonk	Malpura, Tonk.
Bikaner	Bikaner North, Bikaner South.
Churu	Rajgarh, Ratangarh.
Ganganagar	Ganganagar, Hanumangar, Karanpurh, Nohar, Raisinghnagar.
Barmer	Baltora, Barmer.
Jaisalmer	Jaisalmer, Pokran.
Jalore	Bhinmal, Jalore
Jodhpur	Jodhpur, Phalodi.
Nagaur	Deldwana, Merta, Nagaur, Parbatsar.
Pali	Bali, Jaitaran, Pali, Sojat.
Sirohi	Abu, Sirohi.
Bundi	Bundi Nainwa.
Jhalawar	Aklera, Jhalawar.
Kota	Baran, Chabra, Chechat, Kota.
Banswara	Banswara, Khushalgarh.
Bhilwara	Bhilwara, Gulabpura, Mandalgarh, Shahpura.
Chittorgarh	Begun, Chittorgarh, Kapasin, Nimbahera, Pratapgarh.
Dungarpur	Dungarpur.
Udaipur	Bhim, Phalasia (Udaipur), Rajsamand, Sarada, Udaipur, Vallabhanagar.

Surrounded by West Pakistan on the west and north-west this state has Punjab, Haryana, Uttar Pradesh, and Madhya Pradesh to its east and north east, and Maharashtra to its south west.

The main physical features of the state are—

(1) The north western dry land

(2) The central Montane tract

(3) The South eastern tract

The North Western Dry Land

These areas consist partly of a sandy plain, which merges into the plain on the north, and partly of a series of elevated regions. The latter rise on the west of the mountains of Aravalli. The climate of the desert is continental in temperature, and is marked by deficient rainfall. Most

of the south and west consists of a sandy desert. The region is occasionally visited by terrible dust-storms, and sand is encroaching on districts where cultivation was formerly possible. In the east the soil is clayey, but barren; while on the south stretch saline wastes, dotted with lakes and crossed by small streams, that disappear in the ground or lose their waters by evaporation.

The whole of the interior of Thar desert suffers from drought, and also from great changes of temperature. Frost is not unknown at night; while by day the absence of vegetation increases the absorption of heat by ground, and consequently the amount of heat radiated from it. These changes of temperature affect the rocks, for with cold they contract and with heat expand, and the result is a tendency to crack and disintegrate. Any pieces of rock thus split of are blown along by the wind, and not only carve, scratch, and polish the rocks with which they come in contact, but are themselves in time reduced to sand. In some places this process has gone farther than in others, and thus, while the eastern part of the desert consists largely of gravel and flint, that farther south is of sand. Even the sand deserts vary, not only in colour, but in surface, according as the action of the wind forms sand-dunes or scoops out hollows. North of Barmer the sand over a large tract is of a brilliant red hue, but in some other parts it is yellow or white. There are no permanent streams and only a few wadis, or channels, occasionally supplied with water after rain, but never with enough to reach the sea. There are, however, springs which create oases, where date-palms, cereals, and pulses can be cultivated, and water can be obtained in many places by sinking wells. Even in the most arid regions some thorny plants will thrive, and most parts, after a slight fall of rain, are covered with grass. The region is practically sparsely populated. The average rainfall of this region is only 10 inches or 282 millimetres.

The following table shows the monthly rainfall in western Rajasthan or in Thar Desert.

Monthly Rainfall for Thar Desert.

Months	Rainfall in Millimetres	No. of days
Jan.	3.3	0.4
Feb.	5.3	0.5
March	3.6	0.4
April	2.5	0.3
May	7.1	0.7
June	3.3	1.7
July	87.1	4.3
Aug.	99.8	4.4

Sept.	36.6	1.8
Oct.	4.3	0.3
Nov.	1.5	0.1
Dec.	2.5	0.2
Total	282	15.1

The Thar desert of western Rajasthan is a land of contradictions and contrasts. From a bird's-eye-view the general impression would probably be a chaotic jumble of mud coloured mountains. Yet it contains many rich upland plateau (in north east), and at least one broad plain as flat and low lying as any in India. For a brief and fitful season its rivers are rushing torrents, for the greater part of the year there is hardly a trickle in their giant beds. The desert of Thar is a land of rivers without water, of forests without trees, of villages without inhabitants. The whole outlook seems bleak and bare. Yet you have only to scratch the soil and add a little water and you can grow what you please. But often enough nature is so perverse that where there is land, there is no water, and where there is water, there is no land. Large numbers of the inhabitants are pastoral nomads, not merely by habit but by necessity, wandering from place to place in search of grazing grounds or oases for their sheep and goats, camels and other animals. In such a tract the population, though sturdy and warlike, is necessarily sparse.

The Central Montane Region. The Central Montane Region are composed of many ranges, all running from north-east to south-west, and grouped in two parallel belts, with a broad, elevated valley between. The eastern ranges cease east of a line drawn through Ringus and Dholpur, and beyond this lie the Plains of Ganga. The eastern ranges are known in the north east as Biana Hills or Bayana and further south-west flank of the Hills is known as Lalsot. These hills form an area almost entirely isolated by alluvium from the extensive outcrops to the north. Fig. 87 shows that to the south they are completely separated by alluvium and by one of the two great boundary faults of Rajasthan, here concealed by surface deposits, from the plateau of Upper Vindhyan rocks and of the Gwalior and Vindhyan Systems in Eastern Rajasthan; at the eastern end of the hills, near Biana or Bayana this alluvium has a breadth of only 6 kilometres, and the scraps of the Alwar series and the upper Bhander sandstone face each other across the narrow gap. Bayana is the junction for the Agra branch on the Bombay, Baroda and Central Railway route from Bombay to Delhi, broad gauge, and is the only point at which these hills are accessible by rail. The area is very conveniently divided into two sections, the Bayana Hills and the Lalsot Hills. United only by a narrow ridge, Bayana being at the extreme east and Lalsot at the west of the two sections, the two places being 99 kilometres apart. The total length of the hills, measured along their breadth, is 12 to 16 kilometres.

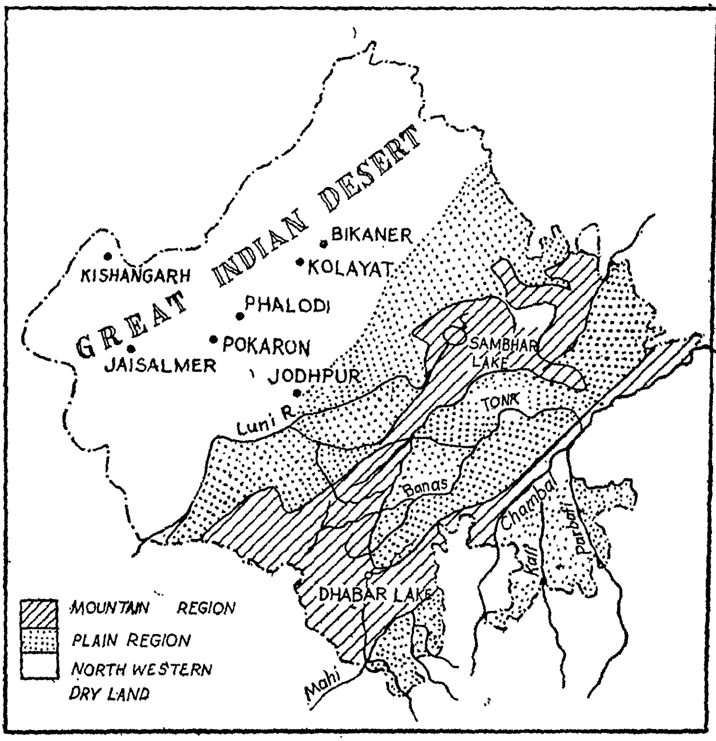


Fig. 87. Physical Divisions

These mountains are chiefly devoted to pasturage, and shawls and carpets from wool thus produced are manufactured at Bhilwara.

Across the middle of Rajasthan there stretches a belt of plateaus flanked by high ranges. The centre of this system seems to be the Aravalli, which are a series of lofty and broad valleys separated and bounded by numerous hillocks. The Aravalli stand at the meeting place of north western dry land and east by rugged topography. The central ranges consist of Aravalli and culminates in the beautiful peak of Mount Abu. Their average height is over 600 metres, while some of the peaks are over 1000 metres. They gradually rise higher towards the southwest forming the peaks of Kho (981 metres), Raghunathpur (1150 m.) and Harisnath (908 metres). From Beawar onwards they form conspicuous ridges while beyond Merwara they spread out into a zone of hills 40 to 49 kilometres. The highest point attained by the Aravalli Mountains is Gurusikhar (1722 metres) in Mt. Abu. Further southwest they gradually become straggling hills forming the rugged country

extending from south west Mewar into Dungarpur and Banswara. They may be said to terminate in the district of Bhukar in south-western Sirohi. The south-eastern flanks extending into Udaipur are less steep than the north-western flanks, the latter being better wooded, because of the slightly higher rainfall on that side.

Throughout this region the range of temperature is very great, and the winters are extremely cold on account of the altitude. The region suffers from lack of rain, for in winter it is an area of high pressure, from which winds tend to blow outwards, and having passed over land are dry, and in summer the surrounding ranges prevent moisture-laden winds from the sea from penetrating so far. The lack of rain and position of the ranges render it difficult for such rivers as exist to reach the sea, and the greater part of the region is, therefore, an area of inland drainage.

THE SOUTH EASTERN TRACTS

This is high, though lower than the surrounding land. It lies almost entirely north east of Udaipur, and is crossed by a series of parallel tributaries separated by ridges, which render communication south and north somewhat difficult. The area is sometimes known as Hadoti on account of its fertile soil, which enable cultivation to be carried on even higher up on the mountain slopes. The climate is hot and rainy in summer, and warm and misty in winter, but irrigation is required for most crops, and especially for rice, which is generally grown under water. Other crops, besides the ordinary cereals and pulses, are cotton, sugar-cane and tobacco.

The flat valley of Banganga and Banas is bounded on the south-west and north by ranges which include some of the highest mountains in Rajasthan. This is a fertile low alluvial plain studded with lakes, and liable to be partly flooded whenever summer rains cause the river to rise higher than usual. The chief products are cereals, cotton and sugar-cane.

The north eastern part of this region also comprises the greater part of the Kali Sind basin. The soil along the river valleys is very fertile, and the rainfall which is brought by monsoon in summer is sufficient for agriculture in the eastern districts.

Rajasthan can be divided into the following climatic areas—

South-Eastern region. The whole of south eastern Rajasthan, embracing Udaipur, Kota and Ajmer administrative divisions and the west of Aravalli, has a climate which is everywhere influenced by the seasonal winds called 'monsoons'. These divisions receive the bulk of their rainfall in summer, for winds blow them from the ocean and evaporate much moisture in crossing the warm Arabian sea. In winter the prevalent winds blow from the land, and are relatively cold and dry. Near the eastern plain, and in mountainous parts, the fall is often ex-

cessive. This area was originally covered by forests, and though these have been cut down in the plains to make room for crops, they still extend over much of ota, Bundi and Jhalawar, besides over the slopes of the central plateaus and ranges. The rainfal var'es considerably in amount in different parts as shown in the following table, but everywhere it occurs chiefly in summer.

TABLE : Normal Monthly climatic data of temperature (°C-both maximum and minimum) Rainfall (mm.) and number of rainy days for 3 selected stations in S.E. Rajasthan.

Months	Ajmer				Jaipur				Kota			
	Max. T.	Min. T.	Rain Fall	Days	Max. T.	Min. T.	Rain Fall	Days	Max. T.	Min. T.	Rain Fall	Days
Jan.	22.6	7.6	9.4	1.0	22.9	8.2	11.2	1.0	25.1	10.6	6.1	0.6
Feb.	25.0	9.9	6.6	0.7	25.0	10.3	8.1	0.8	27.8	13.0	5.3	0.5
March	30.9	15.7	5.8	0.7	31.3	13.2	8.6	0.9	33.7	18.4	4.3	0.5
April	36.3	21.9	3.8	0.4	36.8	20.4	4.3	0.5	38.7	24.3	5.3	0.5
May	39.4	26.8	16.3	1.5	40.0	24.9	14.5	1.6	42.0	29.2	11.9	1.0
June	38.0	27.7	61.7	2.7	39.5	26.9	56.9	3.9	40.4	29.5	67.1	4.1
July	33.2	25.8	162.8	8.9	34.6	25.7	196.6	10.3	34.4	26.6	257.6	11.1
Aug.	30.9	24.4	171.5	8.4	32.7	24.4	204.7	10.2	32.0	25.4	245.4	10.4
Sept.	32.9	23.6	68.6	4.0	33.9	22.7	81.8	4.7	33.5	24.7	119.6	5.7
Oct.	33.1	18.1	9.7	0.7	34.5	17.9	12.2	0.7	34.8	21.3	16.5	1.0
Nov.	28.7	11.5	4.8	0.4	29.7	12.1	3.6	0.3	30.4	15.1	5.3	0.6
Dec.	24.1	8.1	6.6	0.4	24.7	8.7	7.6	0.7	26.2	11.2	5.8	0.5
Total	31.2	18.4	528	29.8	32.2	18.1	610	35.6	33.3	20.8	750	36.5

The rainfall is heaviest on the south eastern windwards side on account of its exposure to the moisture laden south-westerly winds and the presence of high ranges behind. These ranges deprive the winds of much of their moisture, so that the interior has a somewhat scanty supply. What falls here comes chiefly in summer.

North western region. The temperature is warm even in winter, and very hot during most of the yea. There is, however, a great difference between day and night, as well as summer and winter temperatures, which is partly due to the absence of sea winds, and partly to the barren nature of the ground, which rapidly receives and radiates heat. The area enjoys very little rain, for it lies in a belt of high atmospheric pressure, from which winds tend to blow away. Any winds from the south west, moreover, will be dry, as they come overland, while the region lies too far north to receive regular monsoon winds. The absence of any very high ranges is yet another cause for the drought.

The temperature of this dry plain, from Jaisalmer to Bikaner, is everywhere very hot; but while in the extreme north rainfall is slight, it is heavy in the central portion, as shown in the following table.

TABLE : Normal Monthly Climatic Data of temperature (°C-both maximum and minimum) Rainfall (mm.) and number of rainy days for 2 selected stations in north western Rajasthan.

Months	Bikaner				Jodhpur			
	Max. Temp.	Min. Temp.	Rain-fall	Days	Max. Temp.	Min. Temp.	Rain-fall	Days
Jan.	22.1	8.3	6.9	0.8	24.6	9.2	3.8	0.3
Feb.	24.9	10.9	6.9	0.7	27.0	11.4	6.1	0.6
March	31.5	16.9	5.8	0.6	32.5	16.4	2.8	0.2
April	37.5	22.9	4.8	0.5	37.4	21.6	3.3	0.5
May	41.7	27.7	15.0	1.3	40.8	26.3	10.4	1.1
June	41.7	29.4	30.7	2.2	39.8	27.9	36.1	2.1
July	38.4	28.2	84.4	4.9	36.1	26.8	100.8	5.5
Aug.	36.4	26.9	91.4	4.9	33.2	25.0	122.9	5.9
Sept.	36.7	25.6	33.3	2.1	34.6	23.6	61.0	2.8
Oct.	35.4	21.4	5.3	0.4	35.3	18.6	8.1	0.5
Nov.	29.8	14.3	1.3	0.1	30.9	13.0	2.8	0.2
Dec.	24.1	9.3	5.1	0.5	26.1	10.3	2.8	0.3
Total	33.3	20.2	291	19.0	33.2	19.2	361	20.0

Fig. 88 shows the distribution of normal rainfall for selected stations in Rajasthan.

Irrigation and Power. There are many irrigation projects in Rajasthan. Names of Irrigation projects in operation in the state showing the area irrigated in hectares are shown below :

Projects	Irrigated Area in hectares
Madar	214.8
Fateh Sagar lake with canals	220.0
Swaroop Sagar and Pichola with channels	99.6
Bhupal Sagar Tank	916.0
Jaisamand lake	3730.0
Rajsamand	1950.8
Naharsagar	1921.6
Ummed Sagar	2125.6
Ramgarh Canals	2025.6

Parvati Canals	3594.0
Chapperwara	1708.8
Kalakho Sagar	2627.2
Toti Sagar	2042.4
Sainthal Sagar	846.4
Ramgarh	5250.0
Pichuna Canal	3390.8
Ramsagar Canal	2629.6
Urmila Sagar Canal	1967.6
Gang Canal	285122.4
Ghaggar Canal	.68 lakh hectares

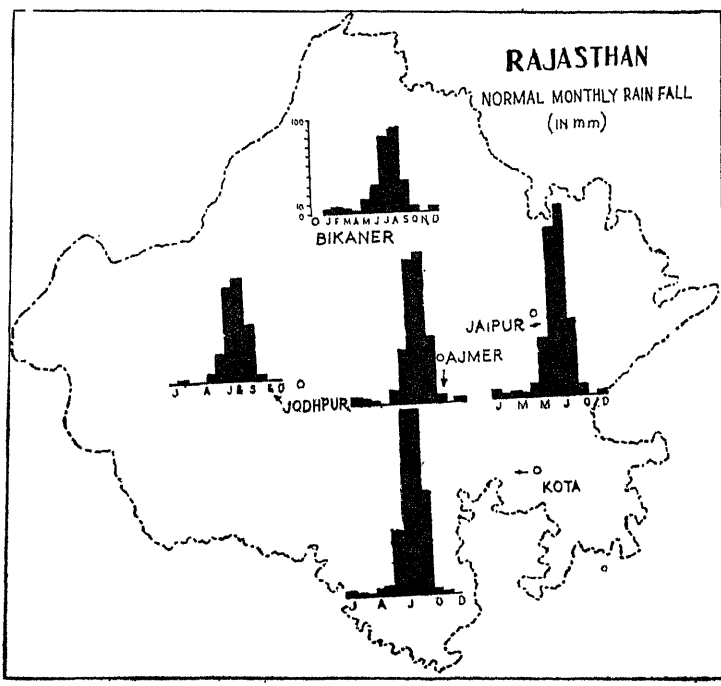


Fig. 88. Distribution of normal rainfall

The construction work of the Rajasthan canal, which is being done from the Harike barrage across the Sutlej, was started in 1959 near Hanumangarh. The Suratgarh branch and Rawatsar distributary have

been completed. The completion of this project by 1970 will, no doubt, transform the economy of the north-western arid zone.

Irrigation from the Bhakra-Nangal project commenced in 1954 and by now 8.68 lakh hectares of land has benefitted from it, as against a total irrigation potential of 22.80 lakh hectares. Irrigation from Chambal project commenced five years ago. This is a multistage project for the development of both irrigation an d power facilities and its second phase, the Maharana Pratap Sagar Dam was completed. In the South-western part of the state, work has been started on the Mahi irrigation-cum-power project. The Mahi project, which is a joint venture of Rajasthan and Gujarat.

In addition to many Government owned power houses in state there were privately owned power houses at the following places : Bundi, Udaipur, Pali, Rajgarh, Abu Road, Bhiwani-mandi, Ladnu, Nawalgarh, Pratapgarh, Banswara, Hanumangarh, Suratgarh, Garhi, Nathwara, Pilani, Merar, Kuchaman, Ajmer and Beawar.

Substantial power from the Bhakra and Chambal projects has become available during the last few years. This has acted as a stimulus for industrial development. Chambal Hydro-electric scheme is a multipurpose scheme and served over 30 localities in Rajasthan.

Minerals

Rajasthan is an important mineral and building stone producing state. The important minerals are iron ore, limestone, fluor spar, lead and zinc, kyanite, manganese, clays etc.

Iron ore. Iron has been worked in the distant past near Jhaj, 3 kilometres to the south of Hathori in a great trench. The ore was probably a breccia cemented by hematite. It is too impure to be of any value at the present day. A study of iron ore deposits had been made by the Geological Survey of India near Pansal (Bhilwara), Lohargarh, Indargarh, Jhalana, Thur-Henden (Udaipur), Kuakhera, Begu and Chainpura (Bhilwara), Loharpur (Bundi). The deposits of iron ore were recorded by G.S.I. close to Nathara-Ki Pal, in Udaipur district.

Manganese. Several deposits of manganese have been recorded by Geological Survey of India in Kadiya, Gangasar, Badgaon, Nathwara, Kalakhuta, Itala and Kushalgarh.

Copper. A kilometre west of Nithahar is a small copper working in the Nithahar beds, it is a narrow and inclined open-cut. According to Hacket copper deposits are also found in Alwar, Moran, Khodariba, Kota etc. Copper smelting factory was established at Khetri.

Lead and Zinc. Small lead occurrence was investigated in Alwar district near Gurah and Rakhabdeo. Deposits of lead and zinc are known to occur in Jabar in Udaipur, the most promising being the Mochiya Magra, Bada Magra where investigations on a detailed scale are

being carried out by the Geological Survey of India. Investigations on lead deposits of Jabar, also examined the zinc ore deposits at het same place in Udaipur.

Steatite. The steatite quarry is in the scarp of Alwar beds immediately west of the Alwar town. It opens up a very small mineral body and has not been worked for fifteen years, as the pieces got out became too small for the manufacture of toys and plates.

Kaolin and pipe-clay (Sal Khari). At one kilometre to the south-east of Rasnu, along spacious tunnel has been driven along the strike of a bed of Kaolin, which runs midway in the ridge of Alwar quartzites. Kaolin is also dug from the soft agrillaceous and talcose zone near the base of the Alwar series in the ridge joining the Biana and Lalsot hills, chiefly near Mathasur.

Kyanite. The earliest prospecting for kyanite was done in 1944 near Mangiabhata in Dausa. This work was intensified after the formation of Rajasthan and two areas of Kyanite were discovered, prospected and small deposits located in Dungarpur district. The name of the places are Dewal and Choti Padri.

Fluorspar. Prospecting for fluorspar was done by the state's Mining Department in Jaipur as early as 1943 but in 1950-51 again reconnaissance, pitting and trenching for this mineral was taken up near Chokri in Sikar District. While searching for some other minerals, particularly lead and kyanite, the department located a fluorspar occurrence in Dungarpur district in 1956. This occurrence was later thoroughly investigated geogogically and core drills were used. Nearly 2438 metres of core drilling has been done to establish a two million ton reserve of about 20 per cent calcium fluoride bearing mineral. The work of prospecting is still under way.

Limestone. Rajasthan has rich limestone deposits. But only two cement plants have so far been established. One at Sawai-Madhopur and another at Lakheri. The establishment of new cement units depends on the location of high grade limestone.

It is now established that good grade limestone for cement manufacture is available near Chittorgarh, Abu Road, Morthala, Pindwara, Neem-Ka Thana, Maonda, Kotputli etc. Slight inferior bands of limestone but showing heavy tonnages are known to be available in the Ranganjmandi Modak track in Kotah district and also near Kela Devi, a place 38 kilometres from Hindaun railway station.

Clay Deposits. With respect to clays Rajasthan stands foremost particularly when the present demand of the industry for refractories, electrical insulators etc., has increased manifold. Several clay deposits have been investigated and their names are given below : Sawa, Narain and Binota (Chittorgarh); Botia, Khajuvaba, Mundwa and Literia (Jodhpur), Palana, Newagaon, Mudh, Kotri and Chandi (Bikaner);

Nanak Chowk, Badra and Sirel (Kotah), Mangroop (Bhilwara), Basu, Raisina and Phalodi (Sawai-Madhopur); Torda, Purushottampura, Buchare (Sikar), Baswa (Alwar), Ghaskoki Dani and Kotputli (Jaipur).

Agriculture

The rainfall is uncertain and much of the state is too dry and rocky for cultivation, yet there are fertile valleys and plains which produce very fair crops when irrigated. There are two chief crops in the year, one sown in autumn, the other in spring. Wheat, gram, barley and beans are the winter crops; rice, bajra, jowar, maize, small millets are kharif crops and sown in spring.

Main cash crops of the state : Oilseeds, sesamum, rape and mustard, linseed, ground nut, cotton, sugarcane, tobacco, chillies, potatoes.

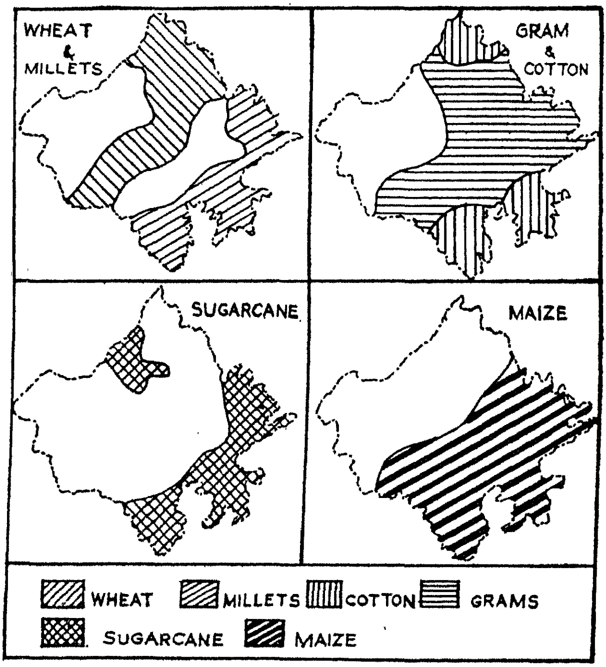


Fig. 89. Crops of Rajasthan

Wheat is mostly grown in the irrigated parts of Bikaner, Ganganagar, Udaipur, Chittorgarh, Bharatpur, Alwar, Jhilwara and Ajmer. Millets are grown in Jodhpur, and Bikaner divisions. Cotton also is grown; it is better cotton than that grown in other parts of India. Sugarcane

is being produced in much larger quantities than formerly. The main areas of sugarcane cultivation are Alwar, Bharatpur, Bhilwara, Kota and Ajmer divisions of Rajasthan. Fig. 89 shows the distribution of crops in Rajasthan.

Rajasthan is no longer a land of famine-stricken people as it once used to be though natural calamities make their visitations now and then. The area under cultivation and irrigation has been steadily increasing. Rajasthan is now a marginally surplus area in food grains, while at the same time the production of commercial crops like sugarcane, oil seeds and cotton has also been steadily rising.

Industries

The most important industries are weaving, dyeing and printing of cotton cloths, manufacture of carpets, rugs and other woollen goods. Among the large-scale industries of Rajasthan, cotton textile, cement, glass and sugar are important.

Cement factories. In the efforts to meet the growing demand for cement the Jaipur Udyog cement factory at Sawai Madhopur, which from modest beginnings in 1953 has now become Asia's biggest single cement producing factory, is playing a big role. The factory was started with a single plant producing 500 tons of cement per day in 1953. Since this was not enough to meet the growing demand an ambitious expansion programme was drawn up. Since 1956 new plants had been installed and nearly Rs. 10 crores invested in the factory which, with a 3000 ton capacity per day, plays an important role in meeting one of the most essential needs of the economy. The second important cement factory is situated at Lakheri near Bundi.

Sugar Industry. Sugar industry ranks as a leading industry of this state. There are two sugar factories, one is at Ganganagar and second at Bhupalsagar. Others are at Bundi, Jhalawara, Madal and Bara.

Cotton Textile. The important centres of cotton textile are at Udaipur, Kota, Kishengarh, Bhawanimandi and Bhilwara, Pali, Ganganagar etc. Numerous other small or big manufacturing units are also in the process of being established.

Glass Industry. At present there is only one glass factory in Dholpur.

Match factory. Only one factory is at Kota. The industry disappeared due to the difficulty of getting raw material of the proper quality.

Copper Smelter. The installation of a copper smelter at Khetri in the public sector and a zinc smelter near Udaipur in the private sector is in progress. The state Government is keen that the production capacity of these two plants should be raised during the fourth plan itself, keeping in view the rich deposits that are available. See Fig. 90.

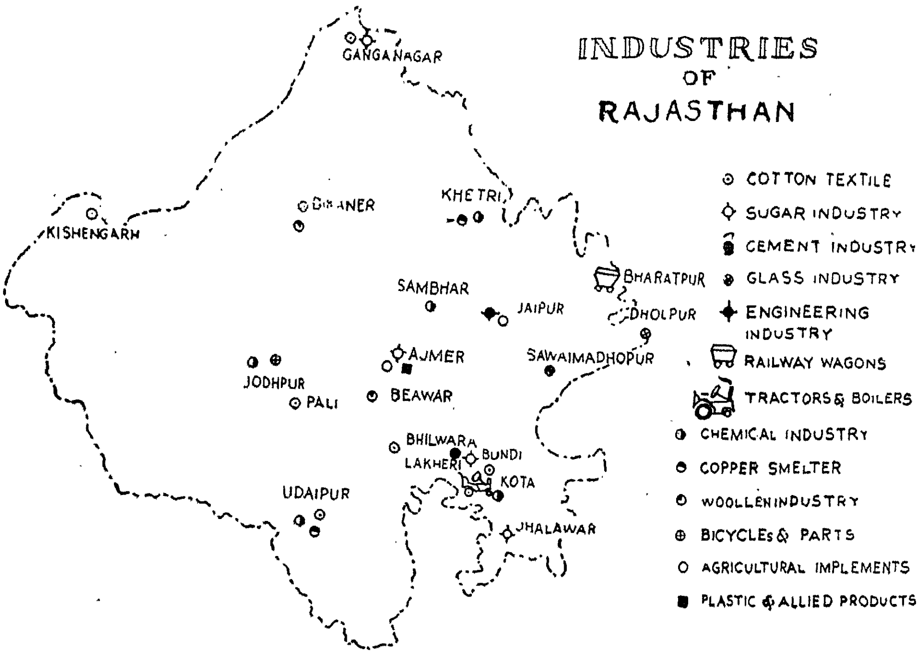


Fig. 90. Location and Industries

Chemical Industries. From these plants (Khetri and Udaipur), sulphuric acid is likely to be available in large quantities as a by-product which, no doubt, will facilitate the establishment of a number of chemical industries. As a matter of fact a factory for the manufacture of triple-superphosphate at Udaipur has already been established. Other chemical industries based on barytes can also be established for the manufacture of carbonates, sulphides, nitrates etc.

Similarly, chemical industries such as soda ash can also be established near Sambhar. The State Government has taken steps to establish a sodium phosphate plant at Deedwana.

Rajasthan have also rich deposits of gypsum. Perhaps the largest deposit in the world has been recently discovered in the Nagaur area, and this has opened up the possibility of establishing a fertilizer plant at Hanumangarh in the north-west.

Engineering Industry. A number of engineering industries are being established. Among the most important units which came into existence during the last decade or so, mention may be made of the National Ball-bearing factory. The Jaipur Metals and Electricals and Man Industries—all at Jaipur.

Precision Instruments. The Government of India have set up a precision instruments factory in Kota, with the assistance of Russian Government. Besides high quality pipes and tubes, this factory also manufactures textile printing rolls. It may be mentioned that there are very few such factories in the world today.

Cottage industries play a significant role in the state's economy. To impart scientific training to cottage workers, three cottage industries institutes and one school of crafts are being run at Jaipur. The handloom industry is the biggest cottage industry of the state.

Soap making. There are about 230 units engaged in soap making. Mostly washing soap is manufactured here.

Oil Pressing. There are about 15 units using power and over 20 units working with bullocks engaged in oil pressing.

The most important cottage and Small Scale Industries are tie and dye fabrics, gota kinari (silver and gold laces), wooden toys, handmade paper, papier mache toys, gem cutting, cloth printing, manufacture of agricultural tools and implements, embroidered shoes (jutiyan) and leather bags, water bottles (Badlas) and handloom weaving.

Population

With a total area of 132,152 square miles, the twenty six districts of Rajasthan state have only 20,155,602 inhabitants or 153 persons to a square mile. The north-eastern region of Rajasthan is a sprinkling of rocky hills, but on the whole of surface is level and the soil fertile, and there is generally sufficient rain. This division is intersected by several rivers. It is better served by railways and has more and better roads than the other parts of the State. The maximum density in this region is reached in Sawai Madhopur. The second highest densely populated district is Jaipur. The southern eastern division consists mainly of forest clad hills enclosing fertile well-watered valleys, but occasionally more open tracts are met with. The western division, which is by far the most extensive, forms part of the North-west dry Area. It has a very scanty rainfall. The physical characteristics of these divisions are clearly reflected in the density of their population. In the Eastern region there are 300 inhabitants to the square mile, in the southern 200, and in the western only 100. In the Jaisalmer in the west, there are only 9 inhabitants to a square mile. On the other hand, in Bharatpur on the north eastern border of the State, the density is 368. Except where the surface is much broken, the density varies more or less closely with the rainfall. In the western division it is greatest (101 persons to the square mile) in Jodhpur, which has below 25 cms., and least, as we have just seen, in Jaisalmer, which has less than 9. The general low density throughout this region is due entirely to its scanty rainfall. The soil itself is often fertile, and if irrigated would no doubt, in some parts at least, be capable of supporting as great a population as the canal tracts

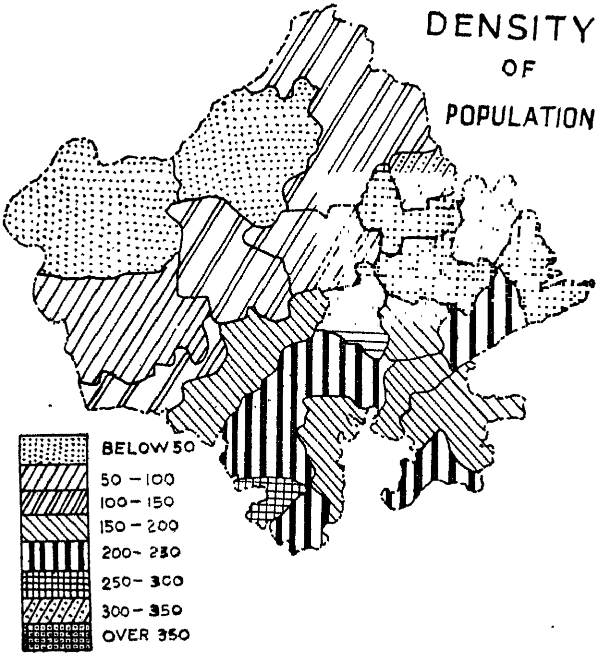


Fig. 91. Density of Population

of the Punjab as shown in Ganganagar district of Rajasthan. Fig. 91 shows the distribution of population in Rajasthan.

The decade 1951-61 has shown an increase of 26.20 per cent or 2.62 percent per annum. Ganganagar district shows the highest growth rate of 64.64 per cent between 1951 and 1961 while Bhilwara shows the lowest of 18.84. The sex ratio for the state is 908 females for every 1000 males, the highest sex ratio being observed in Dungarpur district (991) and the lowest in Jaisalmer (802).

5. MADHYA PRADESH

Capital	Bhopal	*Cities*	*Population*
Area (Sq. m.)	1,71,217	Indore	3,94,941
Population	32,372,408	Jabalpur	3,67,014
Density (per Sq. m.)	189	Gwalior	3,00,587
Females per 1000		Bhopal	2,22,948
males	953	Ujjain	1,44,161

Literacy per 1000	171	Raipur	1,39,792
Principal language	Hindi	Durg	1,33,239
Universities—		Sagar	1,04,676
Sagar, Jabalpur, Indore,		Murwara	60,472
Ravi Shankar (Raipur),		Mhow	48,032
Vikram (Ujjain), Indira Kala		Damoh	46,656
Sangeet (Khaira garh) Shivji		Rajnandgaon	44,678
(Gwalior).		Rewa	43,065

For administrative purposes, the State has been split up into seven divisions with a commissioner at the head of each. The headquarters of each of these are located at Bhopal, Bilaspur, Gwalior, Indore, Jabalpur, Raipur and Rewa.

1.	Bhopal	Sehore, Raisen, Bhilsa, Hoshangabad, Betul, Rajgarh, Shajapur.
2.	Bilaspur	Bilaspur, Raigarh, Surguja.
3.	Gwalior	Gwalior, Bhind, Morena, Shivpuri, Guna, Datia.
4.	Indore	Indore, Ratlam, Ujjain, Mandsaur, Dewas, Dhar, Jhabua, Nimar.
5.	Jabalpur	Jabalpur, Balaghat, Chhindwara, Seoni, Sagar, Mandla, Damoh, Narsimhapur.
6.	Raipur	Raipur, Bastar, Durg.
7.	Rewa	Rewa, Sidhi, Satna, Panna, Chhatarpur, Tikamgarh, Shahdol.

The main physical features of the State are—

1 The Northern region.
2 The Malwa Plateau.
3 The Narmada Plain.
4 The Satpura Hills.
5 The Plain of Chhattisgarh.
6 The Plateau of Bastar.

THE NORTHERN REGION

The Northern Region consists of two old masses—one called western Vindhyan region, which juts northwards, and one jutting eastward, which is the province of Bundel Khand. Bundelkhand is a plateau, and composed of hard crystalline rocks, which yield poor soil. The alluvium soil which has been washed down into the valleys of the Betwa, Ken and Sone is fertile, and the valleys are, therefore, cultivated.

The granite and crystalline rocks of the plateau outside this area are however, infertile, and as the climate is hot and dry the area is mainly a poor pasture for cattle, sheep and goats. The chief towns in the northern region are Gwalior,Rewa, Shivpuri and Katni. Coal fields occur, however, round Rewa, little iron is also found near Sagar and manufactured, and round Ramnagar near Satna. Diamond is still obtained in Panna but the diamond mines there are practically exhausted. Bauxite is mined in Baghelkhand and limestone in Katni. Katni is famous for the manufacturing of cement.

The Malwa Plateau. The Plateau is surrounded by ranges and drained by the Chambal and Kali Sind. Though most of this region is low, it is crossed by two chains of hills which stretch from the southwest to the north. One of these chains has been already described as composed of ancient rocks. This chain lies just east of Ratlam. It is formed of Vindhyan rocks, which also occur in the North Narmada Valley, and extend south of Satna. The other belt of hills starts from Mhow, and includes the Dewas, and extend north of Rajgarh. The hills in both belts have a steep slope to the north east, and a gradual one to the south west. They are, in fact, 'escarpments' formed ages ago by the layers of the rocks of which they are composed having been tilted towards the south-west. Population is somewhat sparse on these hilly belts, but between them lies a low, fertile, well populated tract.

Though the climate of Malwa is not really ideal for the cultivation of paddy. Wheat, gram and cotton are grown throughout the region. Some localities, as a result of varying soil conditions, specialise more in the production of one crop than another. One important fact stands out, and that is that throughout Jhabua famous as this district may be for its wheat lands, a greater acreage is devoted to millets than to wheat. Opium is mostly grown in Ratlam and Mandsor districts of M.P.

Many important towns lie in Malwa plateau. Indore is the chief trading centre. This is also a chief manufacturing town. Bhopal is another important centre in this region.

The Narmada Plain. This plain extends to Jabalpur, and is about 320 kilometres long and 56 kilometres broad. According to Krishnan the main part of the Narmada plain, between Jabalpur and Harda, covers an area 320 kilometres long and 56 kilometres wide. Further down the river, there is another plain from Barwai to Harin Pal near Bagh. Geologically, the deposits of this plain are composed of reddish and brownish clays, with intercalations of gravel and with *Kankar* (calcareous concretions). 'Hard pans' of calcareous conglomerate are often found. The plains are about 30 metres above the bed of the Narmada, this representing the thickness of the deposits. Between Hoshangabad and Narsinghpur the Narmada plain is 12 to 28 kilometres wide and a terrace is found 33 metres above the bed of the river. The plain is surrounded by mountains to is north and south.

The climate is so dry in summer that cultivation depends largely on irrigation, but where this is available the yield is good. The chief crops are wheat, rice, cotton and ground nuts. The plain is densely populated. Jabalpur, a famous city of the region, stands a little north of the river, and is the focus of many routes. It has a large cotton industry, and is noted for cutlery.

The Satpura Hills. Another major region of Madhya Pradesh is that of the Satpura range, with an E. N. E.—W. S. W. direction. The Satpura range in the west are composed largely of Deccan traps, but further east they include Vindhyan and Gondwana sediments and the Archaean gneiss of Jabalpur. Fig. 92 shows the physiography of M.P.

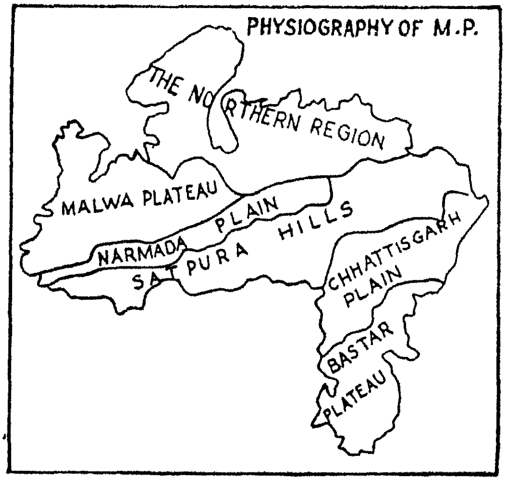


Fig. 92. Physiography of M. P.

This region is a diversified area composed of many ranges, plateau and valleys. Here a hot, moist climate combined with fertile soil has been found suitable for the cultivation of rice and sugarcane. The rainfall diminishes towards the east, but is everywhere sufficient for agriculture. The soil of the western plains is not very fertile, though cotton is cultivated in the centre and potatoes, jowar, bajra and maize throughout the west.

The Plain of Chhattisgarh. This is encircled by Maikala range on the north and west, and by the plateau of Bastar in the south. It is a flat-floored area, which has been covered in the course of ages with soft, fertile soil brought down by the Mahanadi and its tributaries.

The climate of the plain is warm but rather dry. Rice is grown on some of the low fields by rivers, for these can easily be flooded, and

rice grows best under water in its early stages. Other important productions of the plain are gram, linseed, castorseed and wheat. Though farming is undoubtedly an essential part of the economic life of the people, far greater importance must be attached to the development of the coalfields and their attendant industries. Bhilai, an industrial centre a few miles to the west of Raipur, draws its supplies of coal from this area. It is famous for its Iron and Steel Industry. A good deal of iron is mined near Durg and Raipur, and slate near Shivrinarain. Large tracts in the interior are uninhabited, or only inhabited by wandering tribes ruled by their chiefs.

The Plateau of Bastar. Most of the state is occupied by the plateau. On the south there is a steep descent to the Basin of the Indravati, and here the high edge of the plateau is called Chittrakut. On the north-east there is also a high edge overlooking the Pairi basin, called the Sihawa mountains, while on the south the plateau is bounded by Sabari river. The slope of the plateau is from east to west, as can be seen from the general direction of the rivers Indravati and Sabari. They flow at the bottom of deep valleys, which trench the plateau from east to west and convert the intermediate regions into parallel ranges.

The plateau is very hot in summer and fairly warm in winter. It enjoys also a large amount of sunshine, especially in the south and east, where the rainfall is very slight. The rainfall is heaviest on the eastern slopes of the Bastar and the Chittrakut ranges, as these are most exposed to moisture-laden south westerly winds, and the mountains promote condensation. The rainfall occurs chiefly in summer, as it is only in that season that the south westerly winds blow strongly over it.

The inhabitants comprise various tribes. Not only the poorer classes, who are only hunters and fishers, but even the richer, who are also herders of goat and sheep, are obliged to live a nomadic life. Gonds inhabit the Bastar plateau and mountain range which extends thence south-ward into Andhra Pradesh. Physically, they are of short to medium stature, of darkbrown to black skin colour, and with broad flat nose and everted lips. The main occupations of Gonds are agriculture, hunting, fishing and collection of honey.

Mineral and Industry

The state is minerally rich abounding in reserves of iron ore, coal, bauxite, manganese, limestone, clays, corundum, copper ore, diamond and some atomic minerals.

Huge deposits of iron ore occur in Durg and Bastar districts. In the Bastar district the deposit is confined to the Dhalli-Rajhara range of hills with a reserve of 114 million tons and is linked to Bhilai by branch line for supplying the steel plant there. The Balladilla reserves have been estimated at 610 million tons of high grade ore.

There are four coal-bearing areas namely North Chhattisgarh Basin, South Chhattisgarh basin, North Satpura basin and South Satpura basin. Besides, there are five principal coal-fields in the Rewa division.

Large deposits of manganese ore occur in the Balaghat and Chhindwara district. India has been exporting more than a million tons of manganese ore per year, nearly 60% of which comes from Madhya Pradesh.

Bauxite occurs in Jabalpur, Shahdol, Bilaspur, Mandla, Sarguja, Durg, Seoni and Raigarh districts. In Amarkantak Plateau there are extensive cappings of bauxite.

In Katni tehsil of Jabalpur district there are extensive quarries of limestone spread from Katni to Jhukehi supporting a flourishing lime and cement industry at Kymore. Besides, large deposits of limestone also occur in Bilaspur, Raipur, Nimar and Satna districts.

There are several big industries like Bhilai Steel Plant, Heavy Electricals, Nepa paper mills *etc.*, in the state. The State already possesses a number of large scale industries.

Cotton Textile. The state has already 20 textile mills with nearly 12,500 looms and 515,000 spindles, 3 cotton ginning and pressing factories. Average number of workers employed in the textile mills (all shifts) is about 41,907. Cotton textile is concentrated in Indore, Gwalior, Ujjain, Mandsaur, Jabalpur, Dewas, Bhopal, Ratlam, Burhanpur and Rajnandgaon.

Paper Industry. The country's only newsprint mill is located at Nepanagar with a rated capacity of 30,000 tons of newsprint per annum.

Iron and Steel Industry. The Bhilai Steel Plant near Durg has started production. Bhilai exceeded the rated capacity in the production of pig iron, steel ingots and finished steel in 1964. During 1965, the production of pig iron and steel ingots was 14.9 lakh and12.7 lakh tonnes respectively.

Electricals. The heavy electricals of Bhopal have gone into production in Nov. 1960.

Cement Industries. The biggest cement factory of the country is located at Kymore near Katni. The other two factories are at Satna and Barmore with a production of 9,53,000 tons per year.

The state is also famous for traditional village and home crafts. The handloom industry has earned a good reputation for its Chanderi and Maheshwari sarees, kosha silk and other traditional fabrics.

Other important industries are potteries, biscuits, sugar, art silk, diesel engines, jute, glass, engineering goods and rayon. Fig. 93 shows the distribution of industries in Madhya Pradesh.

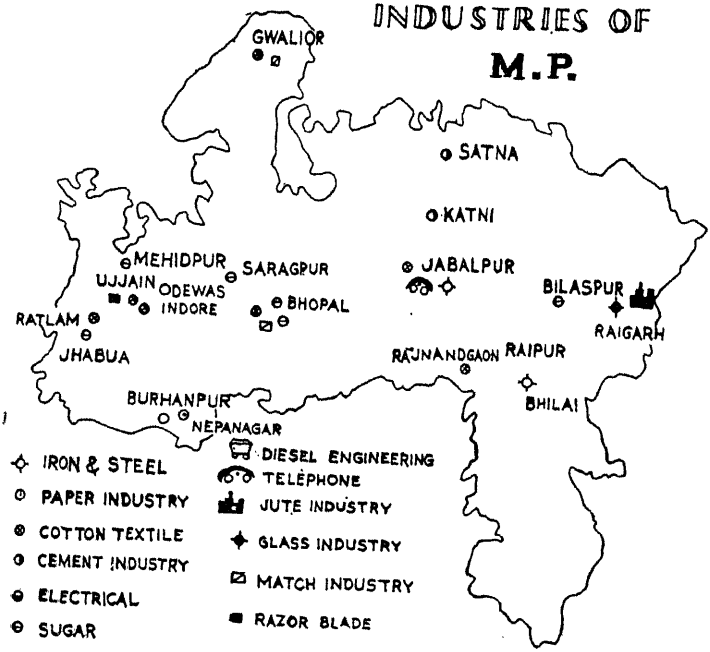


Fig. 93. Industries of M. P.

Population. The population of this state of fortythree districts in March 1961 was 32,372,408, that of males 16,578,208 and of females 15,794,204. The crude density of persons per square mile for the state as a whole is 189, the district of highest density being Indore (510) and of lowest density Bastar (77). Bhopal shows the highest growth rate of 44.82 percent between 1951 and 1961 while Bilaspur shows the lowest of 15.79. The sex ratio for the state is 933 females for every 1,000 males, the highest sex ratio being observed in Raipur district (1037) and the lowest in Morena (839).

6. GUJARAT

Capital	Ahmedabad	*Cities*	*Population*
Area (Sq. m.)	72,245	Ahmedabad	12,06,001
Population	20,633,350	Baroda	2,98,398
Density (per sq. m.)	286	Surat	2,88,026
Females per 1000 males	940	Rajkot	1,94,145
Principal language	Gujarati	Bhavnagar	1,76,473

Universities—		Jamnagar	1,48,572
Gujarat (Ahmedabad),		Nadiad	78,952
Sardar Vallabhbai Vidyapith (Via Anand),		Porbandar	75,081
Maharaja Sayaji Rao (Baroda)		Broach	73,639
		Junagarh	74,294

Districts with headquarters in brackets are as follows :—

Ahmedabad (Ahmedabad), Baroda (Baroda), Banaskantha (Palanpur), Broach (Broach), Mehsana (Mehsana), Kaira (Kaira), Panch Mahals (Godhra), the Dangs (Ahwa), Surat (Surat), Sabarkantha (Himatnagar), Jamnagar (Jamnagar), Bhavnagar (Bhavnagar), Amreli (Amreli), Junagadh (Junagadh), Kutch (Bhuj), Rajkot (Rajkot), Surendranagar (Surendranagar).

Gujarat state is situated on the west coast of India between 20.1 and 24.7 degrees north latitude and 68.4 and 74.4 degrees east longitude. The State is bounded by the Arabian Sea on the West, Rajasthan in the north and east, Madhya Pradesh in the east and Maharashtra in the south.

From the point of view of its physical features Gujarat can be divided into three regions :

(1) The mainland extending from the Rann of Kutch and the Aravalli Hills.

(2) The Peninsular region of Saurashtra and Kutch.

(3) The North eastern hilly tract.

The mainland is almost a flat plain made up of alluvial soil although the northernmost part of it is a bit sandy. The plains of Gujarat are watered by big rivers like the Banas, Saraswati, Sabarmati, Mahi, Narmada *etc.* This is the mainland portion of Gujarat, and on account of its fertile soil and relatively mild climate has become the most densely populated part of the state. The rainfall is heaviest on the western seaboard on account of its exposure to the moisture-laden south westerly monsoon winds and the presence of high ranges behind. These ranges deprive the winds of much of their moisture, so that the interior has a somewhat scanty supply. Whatever rain fall here, comes chiefly in summer.

As the climate is favourable for agriculture, a large part of the area is under cultivation, the rest being occupied by forests and woodland.

A great deal of tobacco is grown in this region, and is manufactured at Ahmedabad. Farther south, in Dhandhuka and Cambay, the chief productions are rice, in the coastal marshes ; timber, sandal wood from the sandy tracts, and cotton in fertile parts on the mainland. The variety grown on these tracts and known as black cotton, is of special value on account of the length of its fibre. Cotton goods are now manufactured in several towns in Baroda, Ahmedabad districts—notably at

Ahmedabad proper which stands on Sabarmati, where water is available. Much of the cotton is exported from the ports of Kandala and Bhavnagar.

The chief crops are wheat, in the north, paddy in the valley of Sabarmati and Mahi as well as in south eastern districts of mainland. Rice is also grown in the coastal swamps of Cambay and Baroda *etc.*

Limestone and petroleum are found in Cambay between Ankleshwar to Kalol. A refinery at Koyali near Baroda was established by Indian Refineries Ltd., in collaboration with the U.S.S.R. Government, with a refining capacity of 20 lakh tonnes per annum. The first 10 lakh tonnes unit has been completed and is running above the installed capacity ; the refinery went on stream in October 1965. The second unit is expected to be completed. This refinery is also being expanded to 30 lakh tonnes capacity by the beginning of 4th plan period. Rich deposits of salt (by sea water) occur round the western end of Broach and limestone in the Gulf of Cambay.

Ahmedabad city which is the second biggest textile centre in India is the only large industrial area in the state. The number of textile mills and factories is about 150 including 71 textile mills with a total number of 20,91,834 spindles and 41,720 looms and employing a daily average number of 1,30,916 workers.

Ahmedabad is also a centre of railway communications. One line from Ahmedabad goes south-east to Baroda and Bombay, another goes south to Dholka ; a third goes west to Viramgam where it joins the Saurashtra railway system, a fourth goes north east through Parantij, and a fifth north through Palanpur and Ajmer. Baroda is the second important industrial city. In recent years a number of factories, big and small, have sprung up. The more important lines of development are textile, chemicals, oil and soaps, engineering, spectacles, a rubber factory, metal works and foundries, rolling mills and manufacture of glassware, *etc.*, providing employment to about 30,000 workmen. Fig. 94 shows the distribution of industries in Gujarat.

The Peninsular region of Saurashtra and Kutch. These consist, south of the Rann of Kutch, of an elevated region bordered by the Girgir Hills on the south, and rising in the west to the high lands around Barda Hills. The greater part of the surface is covered by forests in the south and swamps in the north, and is drained by Luni, Banas, Bhadar and eastern tributaries of Sabarmati.

Geologically the Rann of Kutch was a shallow arm of sea during the Pleistocene period. Even in historic times it was so, as the Indus and the Saraswati of Vedic times flowed into it. It is now silted up and forms an extensive and desolate salt marsh during the dry part of the year and a tidal flat covered with a few feet of sea water during the monsoon. This is everywhere arid, but its surface is diversified. The region is composed partly of sandy soil strongly impregnated with salt,

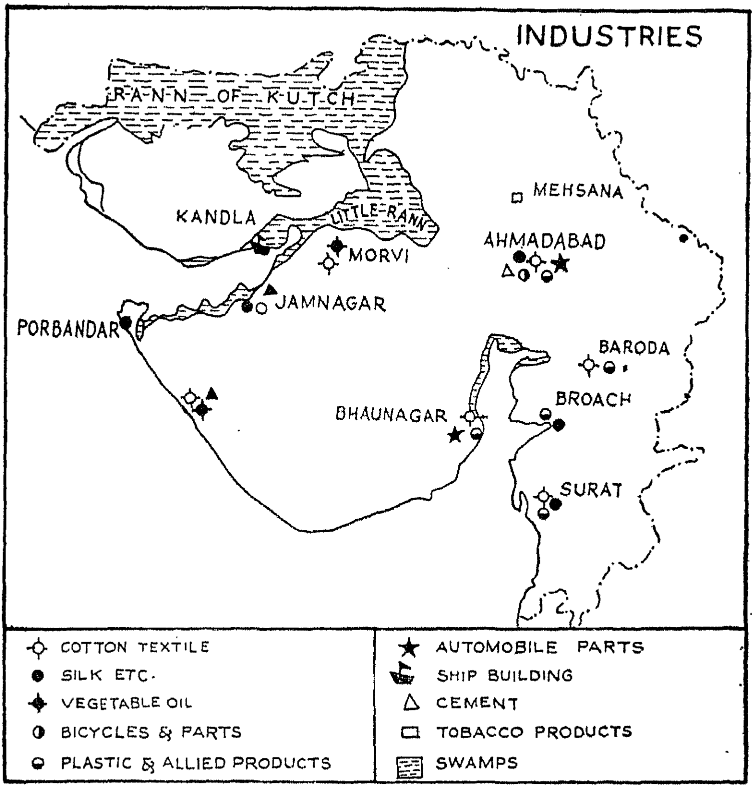


Fig. 94. Industries of Gujarat.

partly of blocks of solid salt, and partly of swamps. The region is practically uninhabited.

The soil is sandy but, with irrigation, cultivation is possible, and cereals and fruits are grown to perfection around Bhuj in Kutch. This town is chiefly important from its central position between Kandla and Mandvi.

In the western region of Kutch there is a fair proportion of good cultivable land. The principal crops being bajra, jowar, wheat, barley, cotton and pulses. The cultivation of groundnuts is also increasing day by day.

The district of Kutch is rich in gypsum, clays and limestone, and has large deposits of lignite, bauxite and ochres.

Geologically, Kathiawar is composed of a marine limestone (Miliolite) around which calcite grains have been formed. It is usually sandy

in the vicinity of the coast, and attains a thickness of 30 metres in western Kathiawar, but is thinner and less extensive in eastern Kathiawar. This Miliolite limestone, also called Porbandar stone, is found on the top of Chotila hills which provides clear proof of the elevation of the coast in recent times. This is locally used as a building stone in Kathiawar. The greater portion of this area is excessively sterile, and the sandy shore is backed by rocky ranges.

The central belt of the peninsula and ranges which extend right across the middle of the region, and broadens out in the south to include all between the Girnar Hills and Girgir Hills.

Here, on account of latitude and oceanic influences, the range of temperature is slight, and the average is high, but modified by altitude in many parts. The rainfall is heavy though it is generally heaviest about the period when the sun is highest.

The staple crops of the north are rice, millet, maize, pulses and in some parts cotton. Large numbers of fish are obtained from the sea, rivers and lakes, and form an important article of diet.

The region is densely populated. The district of highest density being Amreli (432) and the lowest density Kutch (41). The sex ratio for the State is 940 females for every 1000 males, the highest sex ratio being observed in Kutch district (1041) and the lowest in Surendranagar (943).

Kandla in this state is one of the major ports of India. Bhavnagar, Porbandar and Mandvi are intermediate ports and the rest are minor ports.

The North Eastern Hilly tracts. The north eastern tract is surrounded by ranges and drained by the Banas, Mahi and Sabarmati. The rivers, which have deeply trenched the Highlands, form magnificent waterfalls in their descent, especially those flowing westwards. None of the rivers are of any use for navigation, but they afford water power.

This is really a southerly branch of Aravalli lying between Palanpur on the north and Sabarkantha in the south east. It is traversed by many rivers. The highest peak of the hill is Tarango hill. To the north, it probably merges into the Banas Kantha range. This zone shows both sedimentary and old metamorphosed rocks which have been intruded by large masses of granite, probably of different ages. The major forest produce is teak, bamboos, yellow wood, red wood, sandal wood, simal *etc.* The eastern ranges are clad with forests, which form the home of numerous wild animals, including tiger, leopard *etc.* The skins of some of these are of high commercial value.

The region experiences dry, cold northerly winds in winter, and is very cold in the north. The summers are hot, especially in the south, and rain is brought at that season by the south-east monsoon. The range of temperature is fairly great in most parts. The chief products

are cereals, cotton. The principal crops are bajri, maize, jawar, sesamum and groundnut. About 30 per cent of the people consist of Bhils and other backward classes. The main occupation of the people is agriculture. Except for a few ginning factories and oil mills, the region is very backward in industry.

7 MAHARASHTRA

Capital	Bombay	*Cities*	*Population*
Area (Sq. m.)	118,717	Greater Bombay	4152,056
Population	39,553,718	Poona	757,426
Density (per Sq. m.)	333	Nagpur	690,302
Females per 1000 males	936	Sholapur	337,583
Literacy per 1000	298	Nasik	215,596
Principal Language	Marathi	Kalyan	194,334
Universities	Bombay	Kolhapur	193,186
S. N. D. T. Women's	(Bombay)	Amravati	137,442
Poona, Nagpur, Marath-		Sangli	127,183
wada (Aurangabad), Shivaji		Malegaon	126,408
(Kolhapur).		Ahmednagar	119,020

There are 26 districts in Maharashtra State. These 26 districts are grouped into four Divisions :

Bombay Division —Greater Bombay, Thana, Nasik, Dhulia, Jalgaon, Kolaba, Ratnagiri.

Poona Division —Ahmednagar, Poona, Satara, Sangli, Kolhapur, Sholapur.

Aurangabad Division —Aurangabad, Parbhani, Bhir, Osmanabad, Nanded.

Nagpur Division —Buldhana, Akola, Amravati, Yeotmal, Wardha, Nagpur, Chanda, Bhandara.

Boundary. The State is bounded by Arabian Sea on the west, Gujrat on the north-west, Madhya Pradesh on the north, Andhra Pradesh on the south-east and Mysore and Goa on the south.

Physical Features. The State of Maharashtra forms a major part of peninsular India, with the coast on its western side. The Sahyadris or the Western Ghats run quite close and almost parallel to the west coast, leaving a very narrow strip of land between the sea and the lofty mountain barrier, which at no place is more than 96 kilometres in breadth.

This narrow strip of land known as Konkan, stretches from Daman to Vengurla to a distance of about 560 kilometres. Interspersed with hills, the land is very undulating and the soil far from fertile, only suitable for paddy cultivation in flat patches, which lie couched n small valleys and perched on hill slopes.

The north Konkan is a flat alluvial belt along the coast formed by the rivers Ulhas and Vartarna in their lower courses. This belt is not more than 16 kilometres wide, with a series of parallel ridges in the background. To the east of the Sahyadris stretches a vast plateau intercepted by rivers which rise in the Sahyadris and flow eastward. Western Ghats form a serious barrier to communication between the western coast and interior. In the north the table land rises to the Satpura and Vindhyan Ranges, and has an offshoot in the Aravalli Hills. To the south of these Hills and north of a range that continues the direction of the Western Ghats to the extreme south of the peninsula, occurs the depression called the Palghat Gap.

To the north of Nasik is the Satmala ra ge with its continuation in the Balagh t range which goes right upto the eastern border of Vidarbha and Marathwada. This area is bounded by ranges which include some of the high mountains in the Deccan. This is composed of ancient crystalline rocks, which have been worn down till the surface consists of low rounded hills and shallow rock basins. The state is drained by a number of rivers—Tapi (Tapti), Godavari, Bhima, Krishna Wardha and Vainganga. On account of the eastward slope of the land, the chief rivers flow into the Bay of Bengal.

Climate. The rainfall of the Maharashtra state is derived chiefly from the south-west monsoon, between June and October. In the eastern tracts of the Deccan and Karnatak this supply is greatly supplemented by the fall of the north-east monsoon which follows the close of the south-west monsoon. The south-west monsoon touches Kolhapur, the southern most district first and works its way up towards Gujarat. As it advances the amount of precipitation for which it is responsible decreases from south to north along the coast. Thus, Vengurla at the extreme south on the coast receives an annual rainfall of 345 cms.; Ratnagiri about 240 kilometres north receives 250 cms.; Alibag another 160 kilometres in the same direction has 180 cms. while Umbergaon in the north of the Thana district receives only 137 cms.

The high range of the Western Ghats, inasmuch as it arrests the surcharged clouds, receives more rainfall than the coast line over which the clouds come. Thus Ratnagiri, Guhagar, Alibag and Mahim being on the coast line receive 240 cms., 245, 180 and 130 cm. of rainfall respectively, while Devrukh, Chiplun, Lonavla and Igatpuri being on or near the Ghats in the same latitude as the above places receive 350 345, 425 and 355 cms. respectively. It will thus be seen that the western face of the Western Ghats arrests much of the rain. The line of the Western Ghats which runs nearly parallel to the coast, and the rami-

fications of the Ghats on the western side, cause considerable variation in the amount of rain received in the Deccan and Karnatak districts, as the current of the south-west monsoon has to pass across the Ghats. The rainfall decreases eastward and to a less extent westward from the summit of the Ghats. Khandesh and especially eastern portion receives a little additional rainfall from the east, from wind currents originating in the Bay of Bengal.

Minerals. The State is minerally rich. The chief minerals are coal, iron ore, limestone, manganese, bauxite, chromite, silica etc.

The chief coal-fields are—The Wardha Valley comprises the Bandar, Warora, Majri, Rajura, Chanda (Durgpur, Mahakali, Babulpeth and Lalpeth), Ghugus and Ballarpur fields.

In Nagpur district, coal has been proved at Tekadi and Juni Kamptee. Areas between Kanhan and Saoner are likely to contain extensive deposits of coal.

Important occurrences of iron ore are located in Ratnagiri district. Patches of Iron ore, lateritic or otherwise, are also known to occur in Kolaba district, round about Janjira, other important deposits occur Lohara. Asola, Dewalgaon, Bissi, Pipalgaon and Ratnapur.

Manganese is mainly obtained from mines in Vidarbha, Nagpur, Bhandara. In Bombay Division also, the manganese ore appears to be occurring almost side by side with the three iron ore belts running parallel in Ratnagiri district.

Bauxite is mined in Kolhapur, Ratnagiri, Thana, Kolaba, Amboli, Udgeri, Dhangarwadi, Rangewadi, Waki, Gargoti, Ajara etc.

Limestone occurs in various places and in various geological formations. The most important occurrences are confined to Vindhyan formations occurring in Yeotmal and Chanda districts. Limestone deposits are also known to occur in Ratnagiri district to the south-west of Phonda Ghat and in the hills of Hanumat Ghats. Limestone patches occur right from Dabhol to Panvel, Malad to Bassein and Palghat to Dahanu.

Agriculture. The climate of Maharashtra strongly influences agricultural activities. Over most of the state the summer temperatures are generally too high for the ripening of wheat and barley, so that rice is everywhere the most important cereal crop. Rice is abundantly grown n the coastal region of Thana, Kolaba, Ra nagiri and also in Chanda and Bhandara. Fig. 95 shows the distribution of important crops of in Maharashtra state.

Sugarcane is grown in almost all the districts except the Konkan district, the major cane growing districts being Ahmednagar, Kolhapur, Poona, Nasik, Satara and Sangli, Sholapur and Aurangabad.

Although cotton is grown in many districts of the state but Dhulia in western Maharashtra is a major cotton tract of the state.

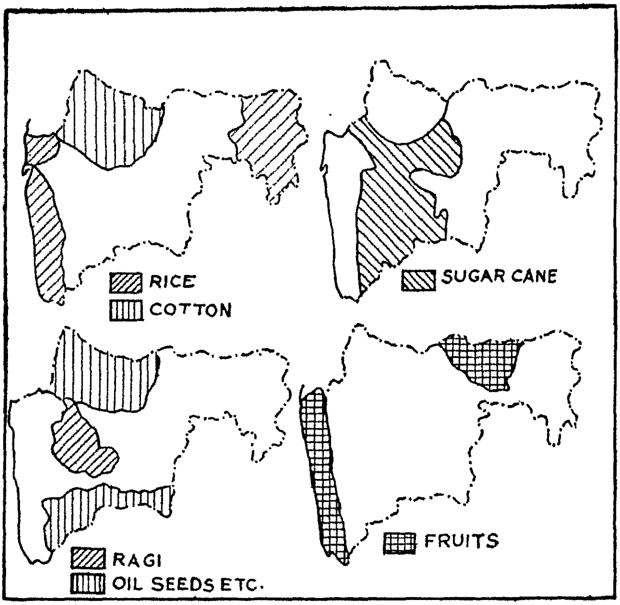


Fig. 95. Crops of Maharashtra

Among the various oilseeds grown in different districts of the State, groundnut and linseed are in leading position.

Horticulture is also important in the state. Thana district is the home of bananas, Nagpur oranges are well known. Oranges are also important in Amravati and Wardha districts. Ratnagiri is famous for mangoes, while cashewnut in every district of the state.

Only about 6 per cent of the cropped area in the state has irrigation facilities as compared to 20 per cent for the country. Among the projects, the names of Mula, Ghod, Yeldari, Mosam, Radhanagari, Gangapur, Ekburjee Morna, Gyanganga, Khuni, Wunna, Bendsura, Dhekum etc. may be mentioned.

Irrigation and *Power*. Maharashtra state is fortunate in having several power projects-both hydel and thermal generating over 6,00,000 kw. of electricity. The important power projects are Tata projects, The Trombay Thermal Power Station, Bhatgar Scheme, Vidarbha Grid Scheme, Chola and Koyna Power projects.

Industries. Important items of industry in Maharashtra are cotton textile, general and electrical engineering, chemicals, sugar, vegetable products, paper boards and soap.

Cotton textile is the major industry of the state. there are 92 textile mills in Maharashtra with 40,14,531 spindles and 79,118 looms and an average daily complement of 2,52,217 workers. Out of these 92 units, 63 are in Greater Bombay alone, with total installed spindleage of 31,54,435 and 61,694 looms, which employ 1,94 ,394 workers daily. Out of the remaining units, four are in Aurangabad division with 87,348 spindles and 1840 looms, seven in Nagpur Division, with 2,60,400 spindles and 5001 looms, 18 in Poona Division, with 5,12,348 spindles and 10,583 looms. Bombay has many large factories for manufacturing linen, rayon, for bleaching and dyeing goods, and for making mineral waters, besides flour mills, tobacco mills and alcohol. Ship building is also a very important idustry. Bombay is progressively undertaking the manufacture of cars, utility vehicles and scooters in three large assembly plants. The bicycle industry is also making headway, having an annual licensed capacity of 2,30,000 bicycles.

In the field of engineering industry, there have been several notable developments particularly in the Bombay region. Some of these are machine tools like lathes, shaping machines, pillar drills, power

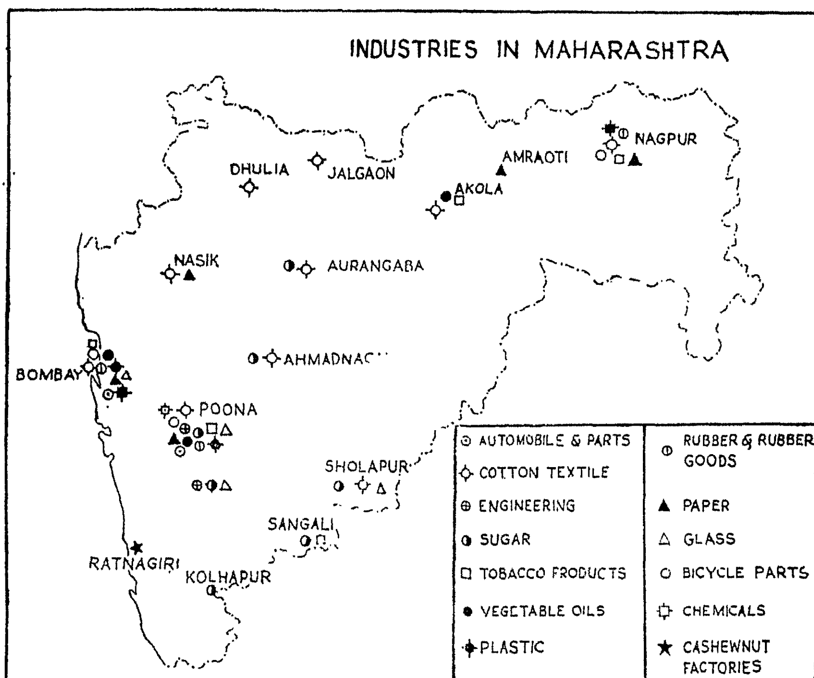


Fig. 96. Industries in Maharshtra

hammers, metal cutting saws, steel and malleable iron castings, welding electrodes, electrical stampings, link chains, steel bells etc.

The engineering industries located at Kirloskarwadi, Poona and Satara are known for their agricultural implements, engines and other products. Fig. 96 shows the distribution of industries in Maharashtra.

Thana and Parnera are the main centres manufacturing a wide range of chemicals. Some of these are glass, gases, oils and soap, paints, pigments and varnishes etc.

Maharashtra is one of the major sugar producing states in the country having 28 sugar factories, with a crushing capacity of 24800 tons per day. They are located in the districts of Ahmednagar (II) Kolhapur (4), Poona (3), Satara (3) Sangli (1) Sholapur (3) and Aurangabad (1).

Population. The population of this state of twenty six districts in March 1961 was 39,553,718, that of males 20,428,882 and of females 19,124,836. The crude density of persons per square mile for the state as a whole is 333, the district of highest density being Greater Bombay (22,323) and the lowest density Chanda (135). The sex ratio for the state is 936 females for every 1000 males, the highest sex ratio being observed in Ratnagiri district (1237) and the lowest in Greater Bombay (663).

Cities. Bombay, situated at the head of ocean navigation, is the capital of Maharashtra, probably still the world's most important commercial centre, one of the world's largest cities and one of the world's largest ports. Bombay is the main centre in Indian Union of the clothing and food and drink industries, of printing, of cinema film production, and of the manufacture of furniture, materials for arts, precision instruments and many other specialised products. Bombay, especially its outer ring, is also an important area for light engineering chemicals and consumer goods and has some heavy engineering plants and a number of important research establishments. Towards the periphery of Bombay and in the new urban development outside it, industry, particularly the electronics and a variety of consumer goods industries, has been expanding rapidly, some of the aircraft plants are in these areas as well as the factories of motor vehicle. In Trombay near Bombay there are large oil refineries as well as shipyards and a variety of other engineering works.

There are five textile mills in Nagpur city, a number of oil mills, a pottery concern, glass works, saw mills, a rubber factory, a thriving frame making industry, a large fruit canning industry and a large number of handloom factories. Nagpur saries are in great demand in all parts of the country.

Ahmednagar is also an important city of Maharashtra. Among industries sugar is now one of the most important. Gur making, hand-

loom, weaving, iron foundries and bidi making are the other important industries.

Besides 3 cotton mills, there are ginning and pressing factories in Kolhapur. There are also ginning and powdering mills, groundnut crushing and oil mills, a sugar mill, cinema film producing companies and soap factories and repair work-shops.

8 MYSORE

		Cities	*Population*
Capital	Bangalore	Bangalore	1,206,961
Area (Sq. m.)	74,210	Mysore	253,865
Population	23,588,772	Hubli Dharwar	248,489
Density per (Sq. m.)	318	Mangalore	170,253
Females per 1000 males	959	Kolar Gold Fields	146,811
Literacy per 1000	254	Belgaum	146790
Principal Language	Kannada	Gulberga	97,069
Universities	Mysore	Bellary	85,673
Karnaak (Dharwar) (Bangalore		Bijapur	78854
Agricultural Science Hebbel).		Davangere	78,124

Mysore state is divided into four Divisions for administrative purposes. The divisions as well as the districts which make up each division are shown below.

1. Bangalore Division —Bangalore, Kolar, Tumkur, Chitaldurga, Bellary.
2. Mysore Division —Mysore, Mandya, Hassan, Chikmagalur, Shimoga, South Kanara, Coorg.
3. Belgaum Division —Belgaum, Dharwar, Bijapur, North Kanara.
4. Gulberga Division —Gulberga, Bidar, Raichur.

Physically, the state divides itself into three natural regions—

(1) The Plain tract or Maidan.

(2) The Hilly tract or Malnad.

(3) The Coastal belt or Konkan.

The Maidan or Plain tract

The Maidan or plain tract comprises roughly the districts of Bangalore, Tumkur, Chitradurga, Kolar, Mandya and Mysore. The Maidan or Plain is in reality a collection of basins, for between the Melagiri and Erramala Hills, which bound it on the east and Malnad on the west it is crossed by numberless short ranges sub-dividing it into many depressions. Some of these are dry while others are watered by streams of uncertain volume. These streams are valuable for irrigation in the Krishna and Tungabhadra Valleys where summers are dry and winter rainfall is nil and partly cut off by Eastern Ghats. The streams also help to bring down the soil which has converted the valley into such a productive area. The Nandi Drug range is noted for gold and the district of Kolar is famous for gold field. In many parts of the valley the surface is generally of a rich deep purple-brown. A dark reddish-brown clay occurs frequently in the banks of the Bhima. This red clay passes upward into the black regur-like alluvium. High lying gravels are often found along the banks of the Krishna. The soil of Raichur is the weatherings of old red sandstone from the plateau. When the river leaves the Western Ghats and enters the Maidan an entirely new kind of country is reached. Every square inch almost of the deep black alluvial soil is cultivated. Rice and wheat are grown in the lowest levels. The hillsides are terraced for ragi, pulses and other crops. Sugarcane is also grown. Silk worms are fed on mulberry leaves.

The chief town in the Maidan is Bangalore which is a junction of many railways. It is a centre of many state-owned and private industries. Four major Government of India undertakings are located here. They are Hindustan Aircraft Ltd. Indian Telephone Industries Ltd. Hindustan Machine Tools Ltd. and Bharat Electronics Ltd. Other industries both in the private and public sector include : soap, porcelain, insulators, electrical transformers, gas mantles, lamps, glass-ware pharmaceutical products, chrome, tanned leather, woollen, cotton and silk mills.

Channapatna is situated to the south-east of Bangalore on the Bangalore-Mysore railway. It is also a centre for sericulture in the State. It contains a Government Silk farm and the Mysore Spun Silk mills, a government aided enterprise. Large quantities of coconuts and betel leaves are produced in the town. Considerable quantities of mangoes are also exported.

The Malnad

Malnad is a vast tract of land lying on the outer westward side of the Maidan. On the north it reaches Belgaum. The mountains bordering Northern Dharwar are rich in minerals. There are good gold mines, but few are worked. There are also deposits of Copper, Silver,

iron and lead. All minerals are associated with Dharwarian rocks. The rocks of the Dharwar system are generally quartzites and fissile schists chloritic talcose, micaceous and homblendic. The quartzites often include much iron ore and all grades are found between quartzite with a few crystals of magnesite or haematite and beds of almost pure micaceous iron ore. The region is minerally rich.

The rainfall on the lowlands and mountain slopes is heavy but temperature varies with altitude, and so does vegetation. These slopes are densely forested yielding cinchona bark, while coco is grown in places. The chief crops are rice, ragi, jowar and various spices, including ginger etc.

THE KONKAN COAST

While the Western Ghats of Mysore is fairly high and rocky, the west is everywhere low, and in parts fringed with shallow lagoons and sand bars, or with mangrove swamps. These swamps are the breeding-places of mosquitoes, which have added to the difficulties of developing these districts. The climate, too, is most unhealthy, being intensely hot and very moist along the west coast. Both the coastal plains and the lower slopes of the ranges behind are thickly forested, yielding coconuts, bananas and pineapples etc. Among the cultivated products are cotton, groundnuts, ragi and some tropical fruits. Mysore state has 320 kilometres of coast line on the Arabian sea. All along this sea board, there are many fishing villages, the most important of them being Karwar, Ankola, Kumta, Honnawar, Bhatkal, Majali, Bingi, Chandia, Gangolli, Malpe, Udiyawar, Bokkapatnam and Mangalore. Nearly fifty varieties of sea fishes are landed out of which the most important are sardine, mackerel, seer and sharks.

Ports are numerous along the western coast, inspite of its unfavourable location, because the chief trade is with foreign countries. Mangalore is the chief port of Mysore, and large ocean vessels can enter the harbour. Farther north is the port of Karwar, which, though not so deep as Mangalore, is more healthy. It is the outlet for the fisheries of the state. The main occupation of the people is fishing and about 80,000 people are engaged in this occupation. Cold storage facilities exist in Mangalore and other places.

There are many irrigational and power projects in the State. The most important are Tungabhadra, Ghalprabha, Bhadra, Dharma, Cauvery and Krishna projects. The total installed capacity of the state is 2 lakh kw.

There are over 11 mills of cotton textile in Mysore with 4,56,860 spindles and 4965 looms and an average number of workers employed in all shifts bei g 25,743. They are located in Bangalore, Davangere, Bellary, Mysore, Hubli, Gadag, Gokak and Gulberga.

46

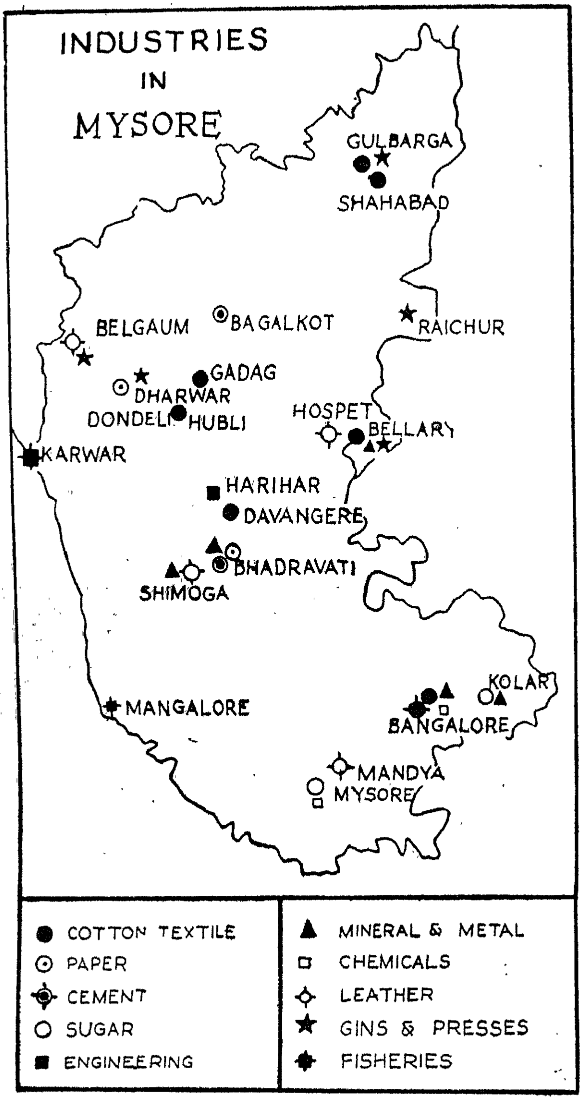


Fig. 97 Industries in Mysore.

Paper Industry. There are in all five paper mills in Mysore, one each at Bhadrawati, Nanjangud, Danddi, Belagora and Dharwar.

Sugar Industry. Mysore is one of the sugarcane producing states in India, having seven sugar mills at Mandya, Hospet, Munirabad,

Kampti, Ugar, Shimoga and Pandavapura. Three newly established sugar factories are situated at Gangavati, Mudhol and Sangesswara.

Cement Industries. There are three units engaged in the manufacture of cement and these are located at Bhadrawati, Bagalkot and Shahabad. One cement factory is also established at Ammasamdra in Tumkur district of Mysore. Fig. 97 shows the industries of the State.

Engineering Industry. The engineering industry in Mysore is developing fast, heavy as well as light. Bangalore is progressively undertaking the manufacture of aircraft, machine tools and electronics.

Ginning and pressing is an important industry in the state located mostly at Davangere, Belgaum, Bellary, Dharwar, Gulberga and Raichur.

The population of this state in 1961 was 23,586,772, that of males 12,040,923 and of females 11,545,849. The decade 1957-61 has shown an increase of 21.57 per cent or 2.16 per cent per annum. Shimoga district shows the highest growth rate of 53.38 per cent between 1951 and 1961 while Kolar shows the lowest of 14.18. The sex ratio for the State is 959 females for every 1000 males, the highest sex ratio being recorded in South Kanara district (1082) and the lowest in Coorg (862). The crude density of persons per square mile for the state as a whole is 318, the district of highest density being Bangalore (813) and of lowest density North Kanara (174).

9. KERALA

		Cities	*Population*
Capital	Trivandrum		
Area (Sq. m.)	15,002	Ernakulam-Cochin	3,13,030
Population	16,903,715	Trivandrum	3,02,214
Density (per sq. m.)	1,127	Calicut	2,48,548
Females per 1000 males	468	Alleppey	1,38,834
Principal Language	Malayalam	Quilon	91,018
University	Kerala	Palghat	77,620
	(Trivandrum)	Trichur	52,685

There are only nine districts in Kerala state : Trivandrum, Quilon, Kottayam, Alleppey, Trichur, Cannanore, Kozhikode, Palghat, Ernakulam.

Nestling amidst the deep blue waters of the Arabian sea in the west and the tall ranges of the Western Ghats in the east, Kerala is a narrow but long strip of coastal territory, from north of Kasargode to the south of Trivandrum. North of Palghat is known

as Malabar coast. The topographical features of Malabar coast differ as greatly from those of the adjacent part of South eastern Kerala as do the climates of the two regions. The flat, sandy, and often barren plains of Malabar are replaced by a very broken, rugged country, out of which rise numerous hills and rocky ridges, the whole thickly covered by rich vegetation. With the exception of a couple of score of square mills immediately to the north of Cape Comorin, the whole of south Kerala lies westward of the watershed along the southern Ghats; which mountain range causes both the moist climate of Kerala and dry climate of east of the Cardamom Hills, by intercepting from the latter practically the whole supply of rain brought by the south-west monsoon, and causing it to fall on their western slopes.

. The state owes its shape to the erosion of the old crystalline rocks which has taken place on the most gigantic scale, proof of which will be adduced further on. Dr. King, in his general sketch of the country, points out the quasi-terraced arrangement the country shows, descending by steps, as it were, from the mountains to the coast. This terrace arrangement is much less well marked, however, in south Kerala (South of Palghat) than further to the north-west. The several terrace steps are marked by the existence of some ridges near the coast higher than the general surface of the country further inland.

The most striking feature in the flora of South Kerala is the immense forest of fan palms (Borassus flabelliformis), which covers great part of the state. The fan palms, or palmyras, attain here to much greater height than they generally do elsewhere. Trees measuring from 25 to 30 metres in height are not uncommon in places, and, with their stems greatly covered by white, or silvery, grey lichs they present a much finer appearance than the comparatively stunted specimens. One is accustomed to see in the Carnatic or in the Mysore and Deccan plateau. Cashew nut (Anacardium occidentale), Jack (Arto Carpus integrifolium) and Alexandrine laurel (calophyllum inophyllum) are the most common in Kerala.

Geologically, in no part of the peninsula, perhaps, is there a greater a finer display of the ancient crystalline rocks than in the south western Ghats in their south half, and in the great spurs a-d outlying masses on their western or southern side. The deposition of the beds in Kerala, (wh n laid down on the map) shows the existence of a great Synclinal curve, probably an ellipse, the major axis of which pas es tl rough, on very near to, the great mass of north of Mahendragiri, while the north-western focus (if the ellipse be a complete one) will be found somewhere to the north-eastward of Alleppey. Several southerly dips wore looks as if the axis of an anticline had there been exposed, but they may possibly only repre ent trifling Vandyke-shaped bends or crumples, in the side of the great Synclinal. To the north of the area

under consideration the rocks role over northward into a great anticlinal fold.

The true bedding of the gneiss on a large scale is extremely well displayed in the great outlying mass known as the Udagiri or Murrorvattoor mountain. The predominant character of the gneiss rocks in this quarter is that of a well-bedded massive, quartzo-felspathic granite gneiss, with a very variable quantity of mica and very numerous small red or pinkish garnets. Scattered grains of magnetic iron are commonly met with in the weathered rocks.

The climate of Kerala is of monsoon type. The rainfall is heavy, save along the mountainous western seaboard, and rapidly diminishes towards the interior. The south-west monsoon, forced to rise in front of the Western Ghats, deposits an excessive rainfall on their seaward slopes, and therefore often fails to bring an adequate supply to the interior region of the state. The temperature is reduced in most parts by elevation, and moderated by oceanic winds. Terrible typhoons s m times occur near the coast, when the winds are changing in equinoctical seasons.

Forests cover a large part of the state, and coconut palms fringe the shores. Not only are the coconuts exported in a natural condition, but the dried kernels called Copra and the extracted coconut oil are also articles of trade. The fibre of the husks also is exported for the manufacture of ropes and matting and mats are locally made from the palm-leaves. Tea has nearly supplanted the coffee plantations, which succumbed to blight some years ago, and coco and rubber plantations are increasing on the lower slopes. Cinchona trees are cultivated both as shade trees for young tea and coco plants, and on account of the quinuine obtained from their bark—the best medicine for malarial fever so rife throughout much of India. Other important vegetable products are cinnamon, rice from the lowlands, and nuts of the areca or betel palm, which are used for chewing all over India.

The chief articles of export and earners of India's foreign exchange among agricultural crops, are cashew kernels, rubber, pepper, tea, coffee, cardamom and other spices.

The beach-sands of Kerala contain several highly valued and strategic minerals like ilmenite, monazite, rutile, zircon and sillimanite. The State is rich in graphite and some precious stones.

There are many irrigational and power projects in the state. The most important power projects are Pallivasal, Sengulam, Poringalkuthu, Neriamangalam, Panniar, Sholayar, Pamba, Idikki, Kuttiadi etc. Major irrigation schemes are Malampuzha, Walayar, Pothundy, Cheerakuzhy, Periyar Valley, Neyyar, Peechi projects etc.

Kerala state, the smallest maritime state in India with just over 544 kilometres of sea coast, contributes to a little over 25% of the total

seafish landed in India. Oil Sardine (Sardinella longiceps) and the Chub mackerel (Rastrelliger canagurta), the two most important shoaling fishes of the west coast contribute to the major fishery of the coast, the third important constituent being prawns. Of the fresh and dried fish a very appreciable quantity is exported out of the state and out of India either in the fresh condition or as cured fish. There are three fishermen Training Centres at Neendakara. Ernakulam and Beypore.

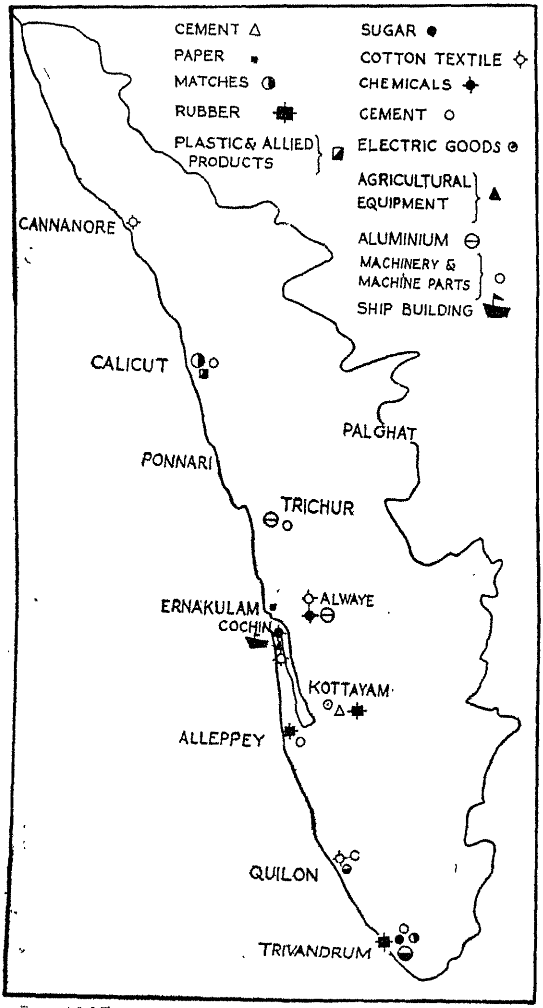


Fig. 98. Industries of Kerala

Most of the major industrial concerns are either owned or sponsored by the Government. Major industries are rubber, tea, coir, chemicals, paper, bricks and tiles, oil, textile, fertilizers, sugar, cement, rayon, shark liver oil etc. Fig. 98 shows the important industries in Kerala State.

The coastal area is primarily important for its coir industry, which although considerably smaller than a generation or so ago, is still the greatest in the world. The coir industry extends over the whole coastal areas and Alleppey. There are numerous cotton and textile mills. There is a southern group of towns engaged mainly in spinning, including Quilon, Alwaye, Trivandrum and Cochin.

State Owned Industrial Undertakings. Travancore Rubber Works, Trivandrum; Travancore Plywood Industries, Punalur; Fertilizers and Chemicals (Travancore) Ltd., Alwaye. The Travancore Rayons Ltd., Perumbhavoor, The Travancore Ogale Glass Mfg. Co. Ltd., Alwaye; Punaloor Paper Mills Ltd., Punaloor; Aluminium Industries Ltd., Kundara; The Travancore Sugars and Chemicals Ltd., Trivandrum. Chief products of the large-scale industries of the state—chemicals, ammonium sulphate, ammonium choride, ammonium phosphate, super-phosphate, sulphuric acid, ammonia, caustic soda, chlorine, copper sulphate, electric porcelain, firebricks etc.

10 MADRAS

		Cities	*Population*
Capital	Madras		
Area (Sq. m.)	50,331	Madras	17,29,141
Population	33,686,953	Madura	4,24,810
Density (per Sq. m.)	669	Coimbatore	2,86,305
Females per 1000 males	5992	Tiruchirapalli	2,49,862
Literacy per 1000	314	Salem	2,49,145
Principal Language	Tamil	Palayamkottai	1,90,048
Universities	Madras	Tuticorin	127,356
	Annamalai	Vellore	1,22,761
	nagar	Kurichi	1,19,380
		Thanjavur	1,11,099
		Nagercoil	1,06,207

There are thirteen districts in Madras. They are : Chingleput, Coimbatore, Kanyakumari, Madras, Madurai, Nilgiri, North Arcot, Ramanathapuram, Salem, South Arcot, Thanjavur, Tiruchirapalli and Tirunelveli.

The physical features of the state are :—

(1) The Eastern Coastal Plain.

(2) Western Highlands.

The Eastern Coastal Plain is a tract of low, mainly alluvial land, and everywhere presents very similar features, but while the northern portion has its rainfall mainly in summer, that of the southern is mainly in early winter. The regularity of the coast line is broken by the deltas of the rivers, which have been irrigated by canals, and by a series of shallow lagoons that are characteristic also of the south-west coast. A canal runs parallel to the east coast for some distance south of the Cauvery. The coast is fringed with coconut palms, and rice is the staple crop, though millet and indigo are also important. The port of Madras owes its importance to its fertile, populous hinterland, and an artificial harbour has only been constructed at great expense. The Madras observatory gives the standard time to India.

The Western Highlands form a belt of ranges and gorges which extend over western regions of the state. A small tract around Cape Comorin, in the extreme south east corner of Nagercoil, has a climate and shows a flora corresponding to the dry one of Tirunelveli. But within a very little distance to the westward a great change begins, and the climate and flora both assume an intermediate character, which may be traced over a tract extending from the Cape like a narrow wedge, having a base of some 32 to 40 kilometres along the coast, with its northern angle in the Arambuli pass. Close to the main mass of the mountains the change of climate and flora is far more abrupt, and really takes place within a distance of a very few hills, *e.g.*, near Mahendragiri, the most southerly high mass of the Ghats (1654 metres) where the change takes place in about 3 kilometres. The real south termination of the Southern Ghats occurs in north latitude 8°15′, where the high mountains sink down into the Arambuli pass. Southward of the pass rises the perfectly detached Kathadi Malai, a fine rocky mass between 609 and 915 metres high, which sends off a rocky spur extending southwards with two breaks, for a distance of 1 or 12 kilometres and terminating in the bold Murtawa hill, 6 kilometres north-west of Cape Comorin. The Cape itself consists of low gneiss rocks, backed up by a palm-grown sand-hill, about 30 metres high. A pair of very small rocky islands rise out of the sea a few hundred yards east of the Cape, any more than are various other rocks occurring off the coast opposite Muttum, Kolachel and Mel Madelolorai, which are the culminating points of reefs formed by ridges of gneiss running parallel with the coast.

To the westward of the Cooletorary river the palmyra trees are less striking features in the landscape than to the eastward. Cashew nut trees (Anacardium occidentall) are also very largely cultivated, and attain to greater size than anywhere in the Carnatic, Jack (Arto Carpus integrifolium) and Alexandrine laurel (calophyllum inophyllum)

are also very common trees in Kanya Kumari. Coco and Areca palms are commonly planted in the sides of the numerous little narrow valleys which scour the face of the country, each with a rice flat in the bottom.

These highlands were originally thickly clad with trees, but the trees are being rapidly cut down. Some forest products, however, are still important, as camphor, which is the hardened sap of a tree; and cinnamon, which is the bark of the twigs of another, while the inner bark of the mulberry tree is used for making paper. Perhaps the most valuable vegetable product of the monsoon region is the bamboo, which is used in the construction of innumerable articles. The leaves are also utilized for thatch and matting and the young shoots cooked for food.

The climate of Madras is hot, though tropical in most parts. Most parts, save a few low coastal plains, are heathy, but terrible destruction to life and property is occasionally wrought by hurricanes, which are most frequent in summer. The heavy rains in summer, when the south west mosoon wind is strongest, have promoted a luxuriant vegetation everywhere, and clothed the western slopes of the ranges with forests. Some of the trees are of high economic value, yielding rosewood, teak, sandal wood and logwood, while coffee, cocoa, and such fruits as bananas, oranges and lemons are cultivated.

The chief crops are sugarcane, tobacco, maize, pineapples arrowroot and various spices, including ginger etc. The principal commercial crops of the state are groundnut, cotton, sugarcane, gingelley, coconut, tobacco, coffee, tea, pepper and rubber. The staple food crops of the state are paddy, millets, ragi, pulses, bajra, jowar, small millets, onions, potatoes, sweet potatoes and tapioca.

The state is minerally rich. Magnesite, bauxite and iron ores occur in Salem District. Ilmenite and Monazite deposits are being exploited in Kanyakumari District. There are nearly 300 tanneries in the state and most of them are non-power tanneries.

Madras ranks first among the states in hydro-electric development and in the use of power for irrigation purposes. The more important ones are Pykara, Moyar, Mettur, Papanasam and Periyar and two thermal stations, one at Madras and the other at Madurai.

Chief Industries in this state are textiles, general and electrical engineering, Sugar, Cement, Tobacco including bidis and cigar manufacture, bricks and tiles, tanning, glassware, chemicals, bicycles, leather and footwear and manufacture of utensils.

Cotton Textiles. Cotton textiles is one of the major industries. There are at present 135 spinning mills in the state. These are mostly concentrated in Coimbatore, Madurai, Tiruchirapalli and Madras. In Madras city is one of the biggest mills in the country employing 13,727 workers. Another large mill in the state is in Madurai, which employs 12,341

workers. The largest employer of labour in the state is the Textile industry.

Sugar Industry. There are five sugar factories in the state. Five more are to be established at Lalgudy, Namakkal, Samayanallur, Thanjavur and Tirunelveli.

There are three cement factories in the state. Fig. 99 shows the industries of Madras State.

There is a paper mill near Cauvery railway station in Tiruchengode. The factory, which would have a production capacity of 20,000 tons a year, would for the present manufacture only writing paper and not newsprint.

Bicycle Industry There are seven bicycle factories in the state. The factory at Ambathur near Madras with an installed capacity of 2 lakh bicycles a year is one of the four biggest factories in the country. The expansion scheme of T. I. cycles to increase their production to three lakh cycles per annum has been finalised.

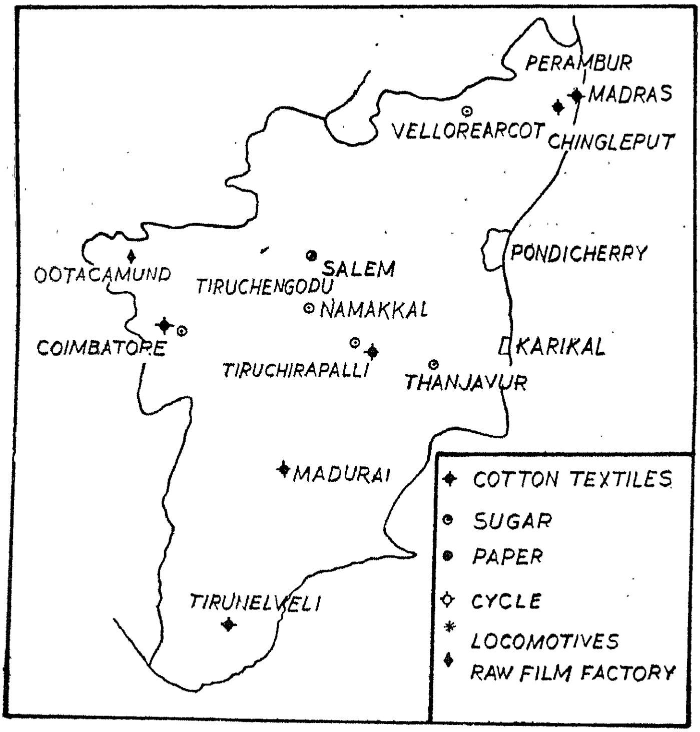


Fig. 99. Industries of Madras.

The other important industries of the state are vanaspat , sulphuric acid, caustic soda, superphosphate, paints, enamels and varnish, soap, carbon dioxide gas, alumina ferric, refractories, electric motors, radio receivers, automobiles and spare parts thereof.

Population. The total pupulation of Madras state in 1961 was 33,686,953 that of males 16,910,978 and of females 16,775,975. The crude density of persons per square mile for the state as a whole is 669 the district of highest density being Madras Corporation (35,289) and of lowest density Nilgiris (416).

11. ANDHRA PRADESH

Capital	Hyderabad	*Cities*	*Population*
Area (Sq. m.)	106,286	Hyderabad	1251,119
Population	35,983,447	Vijayawada	230,357
Density (per Sq. m.)	339	Guntur	187,122
Females per 1000 males	981	Visakhapatnam	182,004
Literacy per 1000	212	Warangal	156,106
Principal Language	Telugu	Rajahmundry	122,865
Universities	Osmania	Eluru	108,321
Andhra (Waltair), Sri Venkateswara (Tirupati), A.P. Agricultur		Nellore	106,776
		Bandar	104,417
Hyderabad).		Kurnool	100,815

Districts of Andhra Pradesh. Adilabad, Anantapur, Chittoor, Cuddapah, East Godavari, Guntur, Hyderabad, Karimnagar, Khammam, Krishna, Kurnool, Mahabubnagar, Medak, Nalgonda, Nellore, Nizamabad, Srikakulam, Visakhapatnam, Warangal and West Godavari.

Physical & Geological

The shape of Andhra Pradesh is rather curious. It has a chain of mountains, the Eastern Ghats, running over its entire length on the eastern and northern borders. The state of Andhra Pradesh consists of two very distinct portions : The coastal plain of Eastern Ghats and second the undulating area of the Eastern Ghats and associated ranges. The former is entirely composed of alluvial formations, the greater portion of its surface being probably composed of deposits from the great river Godavari, Krishna and the smaller streams, the Penner and Musi. The inland hill-tract, on the other hand, is chiefly composed of rocks of very ancient date, so completely altered and crystallized by metamorphic action, that all traces of their original structure are lost, and any organic remains, with few exceptions in coastal regions,

which they may originally have contained, obliterated. The various geological formations to be found in Andhra State may, for convenience of reference, be arranged in the tabular scheme as below :—

Kurnool System	Various Sedimentary Rocks
Kistna Series	Srisailam Quartzites, Kolamnala Shales Irlakonda Quartzites.
Unconformity	
Nallamalai Series	Cumbum Shales Bairenkonda Quartzites.
Unconformity	
Cheyair (Cheyyeru) Series	Tadpatri (Pullampet) Shales Pulivendla (Nagari) Quartzites.
Unconformity	
Papaghni Series	Vempalle Shales & limestones Gulcheru Quartzites.
Archaean—Gneisses and Schists.	

There are hills and table-lands scattered throughout the state. Some of the hills are high and are covered with useful forest, some carry scrub jungle, while many are quite bare. The most useful species of timber produced are kosum, toon, rosewood, irul, teak. Bamboo suitable for the manufacture of paper pulp also occurs in abundance.

The state recognised as a major food-producing region, contributing over 10 per cent. of the whole of the country's production of cereals, it also accounts for 20 per cent of the oilseeds and 40 per cent of the tobacco grown in India. The Telangana region abounds in tanks and artificial lakes constructed mainly for the purpose of irrigation. Telangana is the land of rice and jowar. The rivers dry up in hot weather necessitating the storage of water in tanks and artificial lakes for purposes of irrigation. Rice is the staple food of the people of the state. Wheat is grown as a winter crop in some places. Sugarcane, cotton, oilseeds, groundnut are grown, and much silk is produced.

The chief minerals produced in the state are coal, iron ore, limestone, manganese and asbestos. Large quantity of iron ore has been recorded by G. S. I. in Guntur and Nellore districts of Andhra Pradesh.

The following table gives particulars about power projects in Andhra Pradesh :

Name	Location	Installed Capacity	Production in million units
Machkund	Machkund (Orissa)	59,500 kw.	155.149
Tungabhadra	Mysore State	18,000 ,,	6.587
Nizamsagar	Nizamabad Distt.	15,000 ,,	16.578
Visakhapatnam	Vizag	6,750 ,,	3.198
Vijayawada	Vijayawada	12,000 ,,	1.289
Nellore	Nellore	5,000 ,,	2.789
Hussainsagar	Hyderabad	24,000 ,,	53.556
Ramagundam	Ramagundam	37,500 ,,	..
Giddalur	Giddalur	52 ,,	0.034
Markapur	Markapur	170 ,,	0.005
Cumbum	Cumbum	170 ,,	0.001

The most important industries in Andhra Pradesh are tobacco. It almost holds a monopoly in the production of Virginia tobacco.

The other important industry is textile. In the Telangana area there are eleven textile factories which employ 8,030 persons, 111 tobacco units employing 8,300 persons, two cotton and textile factories employing 600 persons.

There is a ship-building yard at Visakhapatnam. "Darshak" the first ship built in India for the Indian Navy was launched at Vishakapatnam on Nov. 2, 1959. This is a survey ship of 2,750 tons displacement, constructed in the Hindustan Shipyard.

Paper mills are at Sirpur in Adilabad district, Andhra Paper Mills, Rajahmundry, a state-owned commercial concern with a 10 ton capacity per day and the Sri Venkateswara Paper and Straw Board Mills, Tirupathi with a 10 ton capacity per day.

The major cement factories are located in Vijayawada, Adilabad (2) Guntur and Kurnool districts.

There are two fertilizer factories at Kothagudam and Visakhapatnam. Fig. 100 shows the important industries in Andhra Pradesh.

The population of Andhra Pradesh in 1961 was 35,983,447, that of males 18,161,671 and of females 17,821,776. The density of population per square mile for the state as a whole is 339, the district of highest density being Hyderabad (690) and of lowest density (160) in Adilabad. The decade 1951-61 has shown an increase of 15.65 per cent or 1.56 per cent per annum. Khamman district shows the highest growth r te of 30.88 per cent between 1951 and 1961 while Mahbubnagar shows the

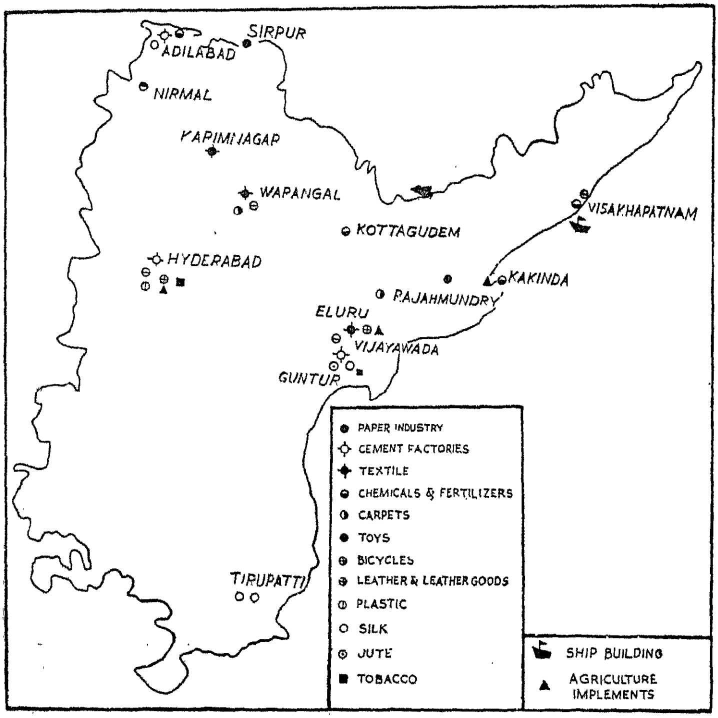


Fig. 100. Industries of Andhra Pradesh

lowest of 9.92. The sex ratio for the state is 981 females for every 1000 males, the highest sex ratio being observed in Srikakulam (1037) and the lowest in Anantapur (946).

12. ORISSA

Capital	Bhubaneswar	*Cities*	*Population*
Area (Sq. m.)	60,164	Cuttack	146,308
Population	17,548,846	Rourkela	90,287
Density (per sq. m.)	292	Berhampur	76,931
Females per 1000 males	1001	Puri	60,815
Literacy per 1000	217	Sambalpur	38,915
Principal Language	Oriya	Bhubaneswar	38,211
Universities	Orissa Uni. of Agriculture & Technology, Utkal Uni. (Bhubaneswar)		

The State of Orissa consists, geologically as well as geographically, of two very distinct portions : the one, a belt of nearly flat tract, from 24 to 60 kilometres in breadth, extending along the coast, and the other, an undulating area, broken by ranges of hills, in the interior.

The former is entirely composed of alluvial formations, the greater portion of its surface being probably composed of deposits from the great river Mahanadi, and the smaller streams, the Brahmani and Baitarani. Near its western limit alone, a few hills of gneissose rock rise from the alluvial plain, especially between the Brahmani and Mahanadi. The inland hill tract, on the other hand, is chiefly composed of rocks of very ancient date, so completely altered and crystallised by metamorphic action, that all traces of their original structure are lost.

In the neighbourhood of the hills, and frequently for many miles from their base, the alluvium of the plains consists of clay and sand, usually more or less commingled, and in most places containing calcareous concretions (Kankar or Ghutin) and pisolitic ferruginous nodules. This deposit passes by insensible degrees into laterite on the one hand, and into the more recent delta alluvium on the other, but in its typical form it is well distinguished from both, by being more sandy and containing nodular carbonate of lime or kankar. The age of this alluvial deposit is shown by its surface having been modified and rendered uneven by the action of rain and streams, so that the country composed of it is more or less undulating. The greater portion has doubtless been produced by deposits washed down by the great rivers from the higher country to the westward, and it appears likely that a portion of these have been deposited along the coast. But other deposits have been in all probability formed upon the original marine beds by the additional accumulations brought down by streams and washed by rain from the hills, so that it is questionable whether the lower marine beds which probably exist are anywhere exposed.

In the neighbourhood of the great rivers the soil is finer and the country level, the greater portion of it being yearly inundated by flood-waters, and receiving a fresh deposit from them, except in places where they are kept from overflow by artificial means. The alluvium thus formed is generally highly fertile, but the country is swampy, and often malarious. As above pointed out, the only character by which this modern alluvium can be distinguished is the flatness of its surface, showing that the area occupied by it is one of deposition, and not of denudation. Usually also it is less sandy than the older alluvium, and Kankar is not of frequent occurrence in it, though a thin layer of it often covers deposits of calcareous sand and clay, from which the later deposit can with difficulty be distinguished. Along the coast, as at Puri, large tracts of ground are covered with sand blown inland from the beach. The nature and origin of the formation is obvious, being simply a deposit of sand carried onward from the margin of the sea by the monsoon, and sometimes rising into ridges and cliffs.

Koraput, the southern district of Orissa, contains a much larger extent of hard rocks than either Cuttack or Balasore. All the country near the coast, and a broad tract in the north-east of the district, all alluvial, but the western part of the area is occupied by laterite, sandstone, and metamorphic rocks. There is a very small extent of the older undulating alluvium. Almost all the eastern part of the state, and the country extending from the Mahanadi to the Chilk lake, is perfectly flat, and consists of the newer or delta alluvium. Hence its liability to flooding from the Mahanadi. Hills of blown sand extend along the whole coast, and frequently are disposed in two or three principal ranges, the first close to the shore, the second from one or 3 kilometres inland, occasionally another range is still farther from the sea.

The greater portion of the state consists of the Athgarh sandstone. The hills bordering on Bhawanipatna consist entirely of metamorphic rocks of various kinds. In the northern part of the range gneiss is found. It appears to be nearly parallel with the escarpment of the range. Granite veins are scarce, but greenstone dykes, or pseudo-dykes, many of them of great size, abound, and most of them, if not all, appear to run parallel with the gneissic foliation. These facts render it probable that the dykes in question are really beds so altered as to be perfectly crystalline. A kind of black magnesian rock, intermediate in composition between potstone and serpentine, approching the former in appearance but less greasy in texture, is quarried to some extent, chiefly for the manufacture of stone dishes, plates and bowls.

Orissa is rich minerally. The important minerals are shown with their location :—

Coal. Deulbera, Talcher and Dera in Dhenkanal district and Hingir-Rampur Colliery, Ib-river Colliery and Orient Colliery in the district of Sambalpur.

Iron Ore. Badampahar, Gorumohisani, Suleipat, Gargari, Hatisikly, Kasiabera, Asuki, Khandadera, Moharajpur, Nangalsila, Katapit, Bhitanmunda in Mayurbhanj district; Kalipati, Sayabali, Bhadrasai, Belkundi, Jhilling, Longnalata, Kasia Guali, Roida, Uliburi, Joda East, Bhilaramda, Kiriburu, Sermeda, Jorugi, Siljora, Bonai and others in Keonjhar district, Temka, Bichhaghatia, Tungeisuni, Tungeisuni and Kansa in Cuttack and Barsuan and Bhandhubhal Barsuan and Taldihi in Sundargarh district, Nabibasa hill in Sambalpur district, Hirapur in Koraput district.

Manganese Ore is important in Thakurani, Belkundi, Bamehari, Kalaparbat, Sayabali, Mangabera, Tiringpahar, Silijora, Kalimati, Dalpahar, Haromotto and others.

Chrome Ore are found in Kamarda, Saruabil, Gurganj, Sukarangi, Kalarangi, Nuasahi, Baula, Birasal, Bhusal Kingal and Kothapal.

Extensive deposits of Bauxite ore occur in the state. Among these, the deposits in Kasipur, Khuniar Plateau, Gandhamardan Hills in Sambalpur-Bolangir district are the most important.

Dolomite deposits occur in Panpos, Jagada and Biramitrapur in Sundergarh district.

The graphite deposits are distributed in Majibheluma, Kariguda in Koraput, Sargipali in Sambalpur, Phapsi, Matupalli, Dharuakhaman, Jamjuri in Bolangir district and Dangsargi, Laitara, Singiharan, Tiekapada, Gudamar in Kalahandi district.

Deposits of Galena occur in Pithaliala Mundabani, Kumbherpanir Tathakni and Netrapahar in Mayurbhanj district, Saintalla in Bolangir, district, Sargipath in Sundargarh district, Gangujal in Sambalpur district.

Other minerls found in the state are Kaolin, Kyanite, Soap stone, China clay, limestone and Venadiferous magnetic ore etc.

Every square inch almost of the deep red alluvial soil is cultivated. Rice and Sugarcane are grown in the lowest levels. The Hills are terraced for Cotton Jowar, Maize, Wheat, Sesamum, Groundnut, Castor, Mustard, Linseed etc. Jute is also an important crop. Silk-worms are fed on mulberry leaves. The climate is warm enough for the bamboo

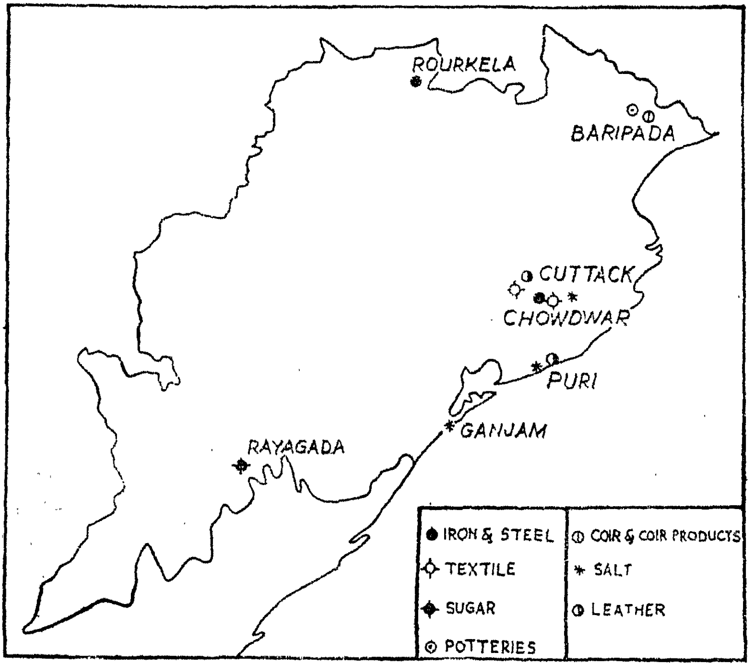


Fig. 101 Industries of Orissa

and camphor tree and suitable for lac. Tallow and varnish are got from certain kinds of trees.

The state's most ambitious irrigation work is Machkund project. Hirakud project is the most important for power and irrigation.

Many industrial undertakings have been taken up in recent years such as (1) Rourkela Steel Plant (2) Ferro-manganese factories at Joda and Rayagada (3) Paper mill at Choudwer (4) Refractories at Belpahar and Rajgangpur (5) Tube industry, at Chandwar, (6) Sugar factory at Rayagada etc. (7) Textiles at Chowdwar and Cuttack, (8) Cement industries at Rajgangpur-Sundargarh (9)Pottariars at Baripada-Mayurbhanj and Barang-Cuttack, (10) Spinning mills at Cuttack, Sambalpur and Mayurbhanj (11) Coir and Coir products at Baripada etc. Fig. 101 shows the distribution of industries in Orissa state.

The population of this state in 1961 was 17,548,846, that of males 8,770,586 and of females 8,778,260. The density of population per squire mile is 292, the district of highest densities being Cuttack (722) and of lowest density Baudh-Khondmals (120). The sex ratio for the state is 1001 females for every 1000 males, the highest sex ratio being observed in Ganjam district (1082) and the lowest in Sundargarh (915). The decade 1951-61 has shown an increase of 19.82 percent or 1.98 percent per annum. Sundargarh district shows the highest growth rate of 37.38 percent between 1951 and 1961, while Baudh-Khondmals shows the lowest of 12.59.

13. BIHAR

		Cities	*Population*
Capital	Patna		
Area (Sq. m.)	67,196	Patna	3,64,594
Population	46,455,610	Jamshedpur	3,28,044
Density (per (sq. m.)	691	Dhanbad	2,00,618
Females per 1000 males	994	Gaya	1,51,105
Literacy per 1000	184	Monghyr	1,46,807
Principal Language	Hindi	Bhagalpur	1,43,850
Universities	Patna,	Ranchi	1,40,253
Bihar (Muzaffarpur), Bhagalpur,		Muzaffarpur	1,09,048
Ranchi, Kameshwar Singh, Sans-		Darbhanga	1,03,016
krit (Darbhanga), Magadh		Chapra	88,264
(Bodh-Gaya).		Bihar	78,581

The following table shows the administrative set up of the state—
Patna Division — Patna, Gaya, Shahabad.

Tirhut Division — Muzaffarpur, Saran, Champaran, Darbhanga.

Bhagalpur Division	Bhagalpur, Monghyr, Purnea, Santal Parganas, Saharsa.
Chhota Nagpur Division.	Ranchi, Hazaribagh, Palamau, Singhbhum, Dhanbad.

The state of Bihar consists, geographically, of two very distinct portions : first the northern flat plain (Bihar is the part of Ganga Plain), and second, Chhota Nagpur Plateau and associated hills.

Almost the whole state north of Hazaribagh consists of alluvium deposits. In Motihari, as in Patna, the largest part of the state consists of alluvium, the older form with an undulating surface, occupying however, a much smaller area proportionally and being confined to the south eastern part of Hazaribagh, nearly all of the remainder being composed of the flat plains of Sone and Ganga and its tributaries.

Between the Rivers Barakar and Sankh, in the Chhota Nagpur of Palamau, Ranchi, Dhanbad and Singhbhum, and scattered over the country to the east of Parasnath, there are numerous hills, all more or less isolated, and all composed of gneiss. Along the Subarnarekha, some miles north west of Jamshedpur, the rock is compact and granitoid. Further south it is less compact, and usually soft from partial distintegration near the surface. It is marked with numerous red blotches, the remains of decomposed garnets. This soft decomposing gneiss is sometimes quarried, and used for building. A few miles west-south-west of Ranchi, near Gumla, the granitoid rocks are replaced by a rough, hard, indistinctly crystalline hornblendic rock, resembling diorite, but exhibiting more foliation than is seen in the Eastern parts of Chhota Nagpur plateau. Still farther to the south west quartz schist appears in a well-foliated form, occasionally containing talc. A detached hill near Lohardaga consists of this rock, and so does the whole south-west portion of the range as far as Garu, except in the immediate neighbourhood of the Sankh River, where it leaves the hill. The northern-most range is free from the Trap dykes which are so conspicuous to the south-west of Chaibasa.

Bihar state is situated in the belt of transition between the wet and humid regions of deltaic Bengal and the arid dryness of the greater part of Uttar Pradesh and Madhya Pradesh. Rainfall is heavier on the plateau than on the low lying Ganga plain but the plains are the real beneficiaries as well as sufferers from draughts and floods.

The soil throughout the whole of that portion of the Ganga plain lying within the state boundaries is extremely fertile, particularly in North Bihar in parts of which the density of the population is more than 900 persons per square mile.

The distribution of minerals is as follows—

Coal. The most important coal fields in Bihar are Jharia, Bokaro, Kurnapura, Ramgarh, Jainti, Rajmahal Hills Giridih and Daltonganj.

Iron ore deposits occur in Noamundi, Gua, Buda, Bune in Singhbhum district and Gere in Palamau district.

India is the large mica producing country of the world as she supplies 80 per cent of the world's requirement of mica—out of which Bihar's contribution is of the order of 66 per cent. Mica in a 144 kilometres long and 32 kilometres broad belt extending from Gaya District to Monghyr through Hazaribagh to Monghyr and Bhagalpur districts.

Bulk of copper ore in India comes from Singhbhum. It is being worked at Mosaboni, Dhobani and Badia in Singhbhum. Deposits of bauxite occur in Pakripat Serendag in Ranchi district and at Netarhat in Palamau district.

Extensive deposits of limestone are found at Banjari Rohtas, Banlia in the districts of Shahabad, Palamau, Hazaribagh and Singhbhum.

China clay occurs in Singhbhum, Ranchi, Dhanbad, Bhagalpur and Santal Parganas.

Deposits of chromite occur near Chaibasa. Apatite deposits occur at Nandup Pathargara Badia Sunrgi in Singhbhum District. Deposits of asbestos occur at Barabana and Sarangposi in Seraikella state and in Monghyr District.

Ochres occur in plenty in Singhbhum district and in Rajmahal hills in Santhal paraganas. Uranium deposits have also been located in Bihar.

There are two chief crops in the year, one sown in autumn the other in spring. Wheat, barley, grams, beans are the winter crops; rice and millet the staple crops sown in spring.

After Uttar Pradesh the most important area of white sugar in India is Bihar. The important sugarcane districts are Champaran, Saran, Darbhanga and Muzaffarpur. Tobacco is grown in Monghyr, Purnea and Darbhanga districts. Other crops are paddy, maize, jute chilly, potato, oilseeds etc.

Bihar has many major as well as minor industries. The main industries are Iron and Steel, and many mills are located in and around Jamshedpur.

One of the biggest public sector enterprises, Sindri Fertilizer Factory, is in this state. Two of the major expansion schemes include the superphosphate factory at Sindri and the insulator factory at Ranchi and the aim is to increase their output from 25 tons to 50 tons per day and the annual production capacity of 2400 tons to 4800 tons respectively. The Tata Engineering and Locomotive Co. at Jamshedpur manufactures locomotives and engineering products. Chittaranjan is also important for locomotive works. Other important ventures are : (1) a

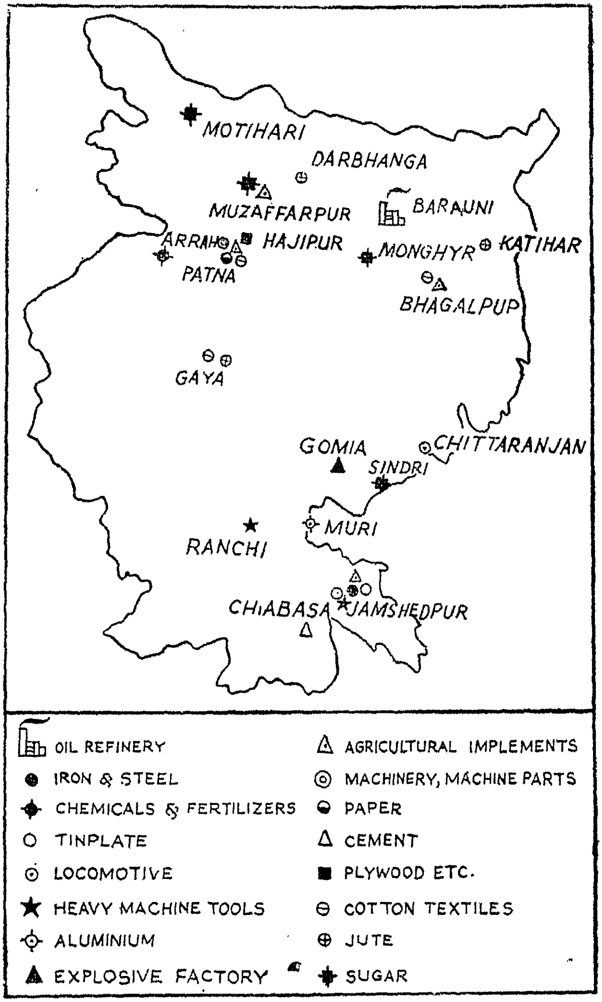


Fig. 102. Industries of Bihar

heavy machine building plant at Hatia (2) a heavy machine tool factory at Ranchi (3) Fourth Steel plant at Bokaro (4) an oil refinery at Barauni (5) Indian Aluminium Co. at Muri (Ranchi) producing aluminium, (6) Indian explosive factory at Gomia.

The Silk industry here benefits by the damp climate, and by the skill which workers have acquired through long practice. There are also large markets at hand for the goods, and every facility for distribut-

ing and exporting them. In some places water power is used in the factories, but coal is taking its place, and this has to be brought from farther south-east. Recently these districts have felt the competition of cotton manufacturing towns in the north, where the cotton plantations are situated, as here the raw cotton has to be imported. The chief centres of the industry are Bhagalpur, Katihar, Patna. Fig. 102 shows the distribution of Industries in Bihar.

There are many sugar factories in Bihar occupying an important place in the rural economy of the state.

The population of the state recorded in March 1961 was 46,455,610 with a population density of 691 persons per square mile. The district of highest density being Muzaffarpur (1365) and the lowest density Palamau (241). The decade 1951-61 has shown an increase of 19.78 per cent or 1.98 per cent per annum. Purnea district shows the highest growth rate of 37.16 percent between 1951 and 1961 while Saran shows the lowest of 13.62. The sex ratio for the state is 994 females for every 1000 males, highest sex ratio being observed in Saran district (1,137) and the lowest in Dhanbad (792).

Bihar has the third largest tribal population in India, next to Orissa preceded by Madhya Pradesh. The tract called Chhota Nagpur is the south-eastern portion of the extensive plateau of Bihar on which are the sources of the Koel, the Subarnrekha, the Damodar and other less known rivers. It extends into Sirgoojah and forms what is called the Udapur Ghat or highland of Jaspur, and it is connected by a continuous chain of hills with the Vindhyan and Kaimur ranges, from which flow affluents of the Ganga, and with the highlands of Amarkantak on which are the sources of the Narmada. That the population of this watershed is found to be, for the most part, a heterogeneous, is in itself a fair proof that these tribes were at one time the inhabitants of the plains who, driven from their original sites at different periods by Brahminical invaders, gradually fell back, following converging lines of river in their retreat, till from different directions, cultures, some bearing marks of common origin though separated for ages, others bearing no trace of such affinity, met at the sources of the streams, and formed new cultures in the secure asylum they found there.

The plateau averages more than 609 metres above the sea level, it is on all sides somewhat difficult of access, and it is owing to the security thus given, that the primitive tribes, still found on it, retained for ages so much of their independence and idiosyncracy. The most important tribes in this tract are the Oraons, Mundas Santhals, Hos, Kharias, Birhors and Korwa. The majority of the people of Chhota Nagpur are tribes consisting of two main groups, the Mundas and the Oraons. The former belong to the Austro-Asiatic family, and the Oraons, on the other hand, belong to the Dravidian family.

14. WEST BENGAL

Capital	Calcutta	*Cities*	*Population*
Area (Sq. m.)	33,829	Calcutta (corporation)	2,927,289
Population	34,926,279	Howrah	555 500
Density (per sq. m.)	1032	South Suburban	341,712
Females per 1000 males	878	Asansol	168,689
Literacy per 1000	293	Bhatpara	147,630
Principal language	Bengali	Kharagpur	147,2535
Universities :		Bally	130,896
Visva Bharati,		Kamarhati	125,457
Jadavpur		S. Dum Dum	111,284
Kalyani		Burdwan	108,224
Rabindra Bharati		Baranagore	107,837
Calcutta		Panihati	3,749
		Seram pore	91,521

There are sixteen districts in West Bengal. They are : Bankura, Birbhum, Burdwan, Calcutta, Cooch Behar, Darjeeling, Hooghly, Howrah, Jalpaiguri, Malda, Midnapore, Murshidabad, Nadia, Purulia, 24 parganas and west Dinajpur.

In its physical characteristics, West Bengal is a level expanse intersected by numerous rivers. The north is broken by the hills of Sinchula, but is elsewhere low, sandy and remarkably regular, the only important opening being the south of Jalpaiguri. Except for the Mountains in Darjeeling district, the surface is uniformly low, and the coastal belt south of Sundarbans is studded by islands.

The soil is partly clay and partly alluvial silt brought down by the rivers. The most important of these rivers are the Damodar and the Hooghly branch of river Ganga. The last is navigable for larger and small boats to a point opposite the site of Manihari and for coasting steamers to its inland port—Patna (in Bihar).

Most wind from the Bay of Bengal make the climate of the state, highly humid, specially in the rainy season, but in cold weather, from January to February, the climate over the entire state is exceedingly pleasant.

The state of West Bengal with a small area of 88.5 lakh hectares, has to provide for a population of 349.3 lakhs. The state is, therefore, after maximum utilization of land. Forests having an area of 11.1 lakh hectares cover 12.5 percent of the total permanent pastures, miscellaneous

tree crops and groves, cultivable waste land and old fallows covering 6.3 lakh hectares are not available for cultivation. The remaining 65.8 per cent of land *i.e.*, 58.2 lakh hectares are put to cultivation. Improved seeds, improved m thods of cultivation, better irrigation facilities, use of fertilizers, plant protection and soil conservation are the methods adopted for stepping up agricultural production. The progress achieved can be estimated from the fact that in 1951-52 the total production of cereals including rice was 3651.7 thousand metric tons while in 1964-65 the figure reached 5,853.9 thousand metric tons. In 1951-52, jute amounting to 2,114.1 thousand bales (of 200 kg. each) was produced. In 1964-65, 3,281.3 thousand bales were produced.

As to the acreage under fibre crops 1961-62 recorded the maximum of 6.1 lakh hectares, next, it went down to 5.5 lakh hectares in 1964-65. It may be noted that the acreage under aus paddy, a major competing crop of jute, has shown a rising tendency during the period. Of the total cropped area, 88 per cent is utilized for growing rice. After rice, jute is the most important crop and accounts for 10 percent of the total cropped area of the state. The plantation covers an area of 170,264 acres and it lies in the districts of Jalpaiguri and Darjeeling. The tea-shrub grows best on hill slopes which allow of good drainage, and prefers a light rich soil with a good supply of vegetable mould. Though the plant can stand severe frost, it does best in a warm climate, and requires most moisture in summer. It takes three to five years for the shrub to come into full bearing ; and as there is a good deal of manual labour connected with picking the leaves at least three times a year, and their preparation for sale, it is only profitably grown where labour is cheap.

During the kharif season of 1965-66 an area of about 500,000 acres was irrigated by the Mayurakshi Reservoir Project against the target of 510,000 acres. A special drive to irrigate 40,000 acres during the rabi season was also taken.

Another project, the Kangsabati Project, has advanced considerably and though still under execution stage, supplied water to about 69,000 acres during the kharif season.

The Agriculture Department took up 166 new Small Irrigation Schemes in 1963-64 as against 755 in 1962-63. The Smaller number has been outweighed by the larger coverage of 43.0 thousand hectares in 1963-64 as against 30.9 thousand hectares in 1962-63.

In the latter part of the Second Plan 59 deep tubewells were drilled in Nadia and 24 Parganas district where the problem of irrigation is extremely acute. About 800 tubewells were drilled during the end of the Third Plan.

West Bengal has shown continuous progress in the sphere of industry during recent years. The number of registered working factories

in the state increased to 5,232 in 1964 from 5,010 in 1963 and 2,974 in 1955 indicating a rise of about 76 per cent. Despite major handicaps in different spheres of economy in 1965 like critical foreign exchange position, severe import restriction *etc.*, the growth seems to have persisted.

According to provisional figures now available ex-factory value of industrial output of large industries (registered factories employing 50 or more workers with the aid of power, or 100 or more workers, without the aid of power, in West Bengal was Rs. 1018 crores as against Rs. 4663 crores of India's output in 1963. In 1962 according to revised data West Bengal's output including two factories in Andaman and Nicobar islands was Rs. 944 crores against India's output of Rs. 4176 crores. These indicated for West Bengal 7.8 per cent rise of industrial output in 1963 as against 117 per cent in India.

Of the Durgapur projects the construction work of the following units progressed satisfactorily:

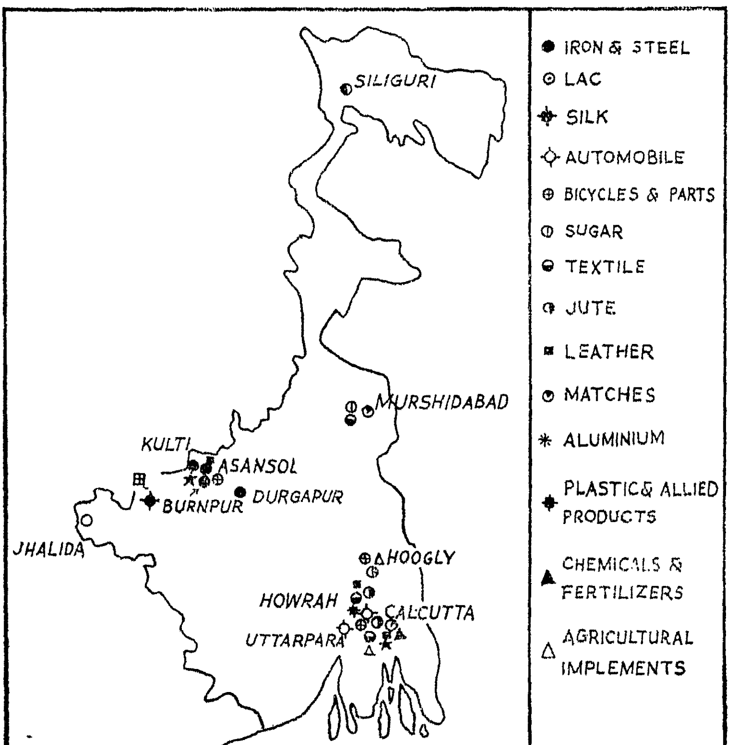


Fig. 103. Industrial Centres

The fifth unit of the Power Plant, the coal washing plant, expansion of waterworks, and the third and fourth units of the coke oven plant.

It is also contemplated to instal a 5th coke oven battery with funds to be provided by the Government of India. The matter relating to the scheme or the sixth unit (150 M.W.) of the power plant is yet to be settled.

Durgapur Chemicals Ltd.—the construction work and the erection of all plants and equipment would be completed by the end of 1966-67 and production will commence thereafter. This construction work, it might be noted, was impeded by the scarcity of heavy structural steel.

Hindustan Steel, Durgapur, made commendable progress during the year 1965.

Under the Second Five Year Plan—five industrial estates (*viz.*, Howah, Saktigarh, Siliguri, Kalyani and Baruipur) were taken up and completed within first three years of the Third Plan. The Third Plan envisaged the establishment of eleven new estates. But due to the re-orientation of the State Plan in the context of the National Emergency, the Government took up only three, one at Asansol for development of ancillaries, one near Calcutta for hides and leather and another small estate at Baruipur as an annexe to the estate already functioning there. Construction of the Second Industrial East has already been acquired and efforts are being made to set up the Asansol Industrial Estate as a co-operative venture.

To meet the problem of unemployment a special programme for encouraging small industries was chalked out during the Second Plan period, and in the light of the experience gained during the Second Plan some new schemes of expansion had been included in the Third and Fourth Plan.

Two major schemes for expansion in this field may be mentioned—

(1) Constructional work is in progress for the establishment .of 25,000 spindles at Habra as a part of the Kalyani Spinning Mills Ltd. It has also been decided to expand the Kalyani unit of the Kalyani Spinning Mills Ltd., for production of hosiery yarn with 25,000 spindles.

(2) The Central Engineering Organization, Howrah, which is a common service facility centre provides marketing technical guidance, raw materials credit and other facilities to the constituent small scale engineering units located in Howrah area. Besides a lock making unit at Bargachia, Howrah a Surgical Insturment Servicing unit at Baruipur, mechanical toymaking factory at Chinsurah, development of tanning and footwear were expanded in the Third Plan period.

The West Bengal Small Industries Corporation Ltd., (a State Government undertaking) has been set up to deal with the matters relating to supply of raw materials to small scale industrial units and for marketing their products.

Power production recorded an increase of 10.0 percent in 1963-64 over the preceding year, amounting to 2726 million kwh. as against 2473 million kwh. in 1962-63.

In 1964-65 there was further progress in this sphere with 4100.6 million kwh. of electricity generated but this figure includes generation by D. V. C. since brought under West Bengal. The installed capacity of generating plants has also been increased by 16.7 percent during this year.

The Bandel Thermal Plant of installed capacity 330 M. W. is on the way to completion. Plan for another large unit at Santaldiher (Purulia) has also been finalised. Also nearing completion is the 27 M.W. Jaldhaka Hydro-electric project in North Bengal.

The population of West Bengal on March 1961 was over 35 millions with a density of 1032 persons per square mile. The highest density being Calcutta (73182) and the lowest density Darjeeling (538) persons per square mile. The decade 1951-61 has shown an increase of 32.79 percent or 3.28 percent per annum.

Cooch Bihar district shows the highest growth rate of 51.95 percent between 1951 and 1961 while Calcutta shows the lowest of 8.48. The sex ratio for the state is 878 females for every 1000 males, the highest sex ratio being observed in Bankura district (981) and the lowest in Calcutta (612).

In West Bengal, after the reorganization of states, there are as many as 41 tribes with a total population of 20,63,883. Important tribes are Santhals, Oraons, Mundas, Koras, Hos, Lepchas and Baigas *etc.*

15 ASSAM

Capital	Shillong	*Cities*	*Population*
Area (sq. m.)	47091	Shillong	102,398
Population	11,872,772	Gauhati	100,707
Density (per sq. m.)	252	Dibrugarh	58,480
Females per 1000 males	876	Silchar	41,062
Literacy per 1000	274	Nowgong	38,600
Principal Languages	Assamese & Bengali	Digboi	35,028
University	Gauhati		

Names of Districts with headquarters in brackets : Goalpara (Dhubri), Kamrup (Gauhati), Darrang (Tezpur), Nowgong (Nowgong), Sibsagar (Jorhat), Lakhimpur (Dibrugarh), Cachar (Silchar), Garo Hills

(Tura), United Khasi and Jaintia Hills (Shillong) which is also the capital of the state, United North Cachar and Mikir Hills (Diphu), Mizo (previously called Lushai Hills) and Aijal.

The physical features of the state are—

Brahmaputra or Assam Valley.

Surma or Barak Valley.

Plateau Region.

The river basins are naturally fertile and present in the main few difficulties to the cultivator. Rainfall being high the problem in general is to dispose of the surplus water and to control the action of floods rather than irrigation in the usual sense. The streams also help to bring down the soil which has converted the valley into such a productive area. Many are noted for their beauty. Of these, the most famous flows through the Kopili Valley, descending in places by a series of magnificent waterfalls. Much of the land is now devoted to rice, oranges, pears and many other fruits. These products can be sent away by rail as well as steamer, for lines have entered the valley at Amingaon. Amingaon, the natural outlet of this velley, has a magnificent inland port.

The Shillong Plateau is bordered in the east by Barail range running east and west, which includes its numerous high peaks. The Barail series (name being derived from the Barail range) occupies a large area north-east of the Haplong-Disang thrust but shows a different lithological aspect. It is well developed in the Surma Valley, North Cachar and the Khasi and Jaintia Hills. The Garo Hills are densely wooded, but owing to the Garo method of cultivation, real forests and trees have almost disappeared except in deep valleys and where Government has established reserves, with the exception of teak trees the country is covered with trees of smaller size and bamboos, save where patches of land have been cleared for cultivation. Many streams take their rise in the higher hills, and finding their way down to the plains over narrow and rocky beds, pour their waters into the Brahamputra and Megna basins.

The only minerals in Assam worked on a commercial scale are coal, petroleum and limestone. Oil and gas shows are fairly numerous in upper Assam and Surma Valley down to the Arakan and a few occur along the southern border of the Shillong plateau. Both Digboi and Badarpur oilfields are situated on tightly folded asymmetrical anticline with major thrust faults cutting the steeper flanks. A small production has been obtained from the Barails in the Makum area while the new Naharkatiya field west of Digboi now produces from the Barails. Oil shows are also known in the Arakan area but there is no producing field. Utilizing the crude oil at Naharkatiya, Moran belt, a refinery in the public sector has been set up at Noonmati, near Gauhati.

In the Shillong plateau of Assam (Garo, Khasi and Jaintia hills) there are several coalfields in the Sylhet Limestone Stage. These coals are generally rather high in volatiles and in Sulphur. The main coal-bearing formation in upper Assam, east of Dhonsiri Valley, is the Barail series. Coal seams are being worked in the Makum, Nazira, Namdang, Ledo and other fields.

Assam is deficient in power development. There are only two power projects one at Umtru Hydro-electric project and second Gauhati Thermal Project at Narangi.

The principal crop in Assam is rice, tea and jute. Among the other crops cultivated in Assam are cotton, tobacco, maize and oranges.

Handloom industry is an age-old industry of Assam. It is the largest and the most important cottage industry next to agriculture. Cotton is plenty in their homes or at their doors and a Garo or Naga is a born spinner and his wife or daughter is a born weaver. The handloom industry is, therefore, rooted deeply in the soil.

The population of the state in March 1961 was 11,872,772 with a population density of 252 persons per square mile. The district of highest density being Nowgong (559) and the lowest density Mizo Hills (33). The decade 1951-61 has shown an increase of 34.45 percent or 3.44 per cent per annum. United Mikir and North Cachar Hills district shows the highest growth rate of 69.08 percent between 1951 and 1961 while Cachar shows the lowest of 23.53. The sex ratio for the state is 876 females for every 1000 males, the highest sex ratio being observed in Mizo Hills (1009) and the lowest in Lakhimpur that is 831.

16 OTHER STATES

(The description of the other States of Indian Union is given in brief.)

(1) JAMMU & KASHMIR

Capital	Srinagar	*Cities & towns*	*Population*
Area (Sq. m.)	86,665	Srinagar	2,95,084
Population (1964)	35,60,976	Jammu	1,02,738
Females per 1000 males	873	Anantnag	21,087
Literacy per 1000	110	Baramula	19,854
Principal Languages	Kashmiri, Urdu and Dogri		
University	Jammu & Kashmir		

Physical Features	(1) Karakoram and Ladakh region in north east. (2) Vale of Kashmir—flat plain. (3) Pir Panjal region in south-west.
Rainfall	(1) Heavy rainfall in the southern slopes of Hills. (2) Moderate rainfall in the middle. (3) Scanty rainfall in Ladakh and northwards.
Agriculture	Chief crops are rice (in valleys), wheat, barley, tobacco and maize.
Horticulture	Walnuts, almonds, pears and apples etc.
Vegetation	monopoly on willow wood (used in the manufacture of cricket bats) pine (resin and turpentine tapping).
Minerals	Gypsum in Jammu, Coal in Murribeds of Jammu and Kashmir.
Industries	The principal manufacture of Kashmir is silk, which is produced in southern and central parts of the state.

(2) HIMACHAL PRADESH

Capital	Simla	*Towns*	*Population*
Area (sq. m.)	19885	Mand	13,034
Population	2,701,144	Nahan	12,439
Density	124		
Females per 1000 males	928		
Literacy per 1000	171		
Principal Languages	Hindi & Pahari		

Districts	Simla, Kulu, Kangra, Lahaul-Spiti, Bilaspur, Chamba, Kinnaur, Sirmur, Mahasu.
Crops	Wheat, maize, barley, rice, potato fruits like walnuts, peaches, plumbs, apricots, apples, grapes and Cherries.

(3) DELHI

Capital	Delhi (capital of Indian Union)		
Area (Sq. m.)	573		
Population	2,658,612	*Cities*	*Population*
Density	640	Delhi	2,061,787
University	Delhi		

Females per 1000 males	785	New Delhi	2,61,545
Literacy rate per 1000	527	Delhi Cantt.	36,105
Languages	Hindi, Urdu and Punjabi		

The main industries are cotton, hosiery, pottery, flour, jewellery, leather goods and tanning, vegetable oil, etc. In Okhla Industrial Estate there are over 45 factories.

(4) PONDICHERRY

Capital	Pondicherry	Females per 1000 males	1013
Area (sq. m.)	185	Literacy per 1000	374
Population	3,69,079	Principal Languages	French & Tamil
Density (per sq. m.)	1995	Towns—	
		Pondicherry	40,421
		Karikal	22,252

Pondicherry Consists of

(1) Pondicherry and Karikal in Coromondel coast.

(2) Yanam with the adjoining territory.

(3) Mahe on Kerala coast.

(5) MANIPUR

Capital	Imphal	Females per 1000 males	1015
Area (sq. m.)	8,628	Literacy per 1000	304
Population	780,037	Principal Language	Manipuri
Density (per sq. m.)	90		

Sub-divisions

(1) Hills sub-divisions (Churachandpur, Mao and Sadar Hills, Tamenlong, Tengnoupal, Ukhrul).

(2) Manipur Plains sub-divisions—Bishanpur Imphal East, Imphal west, Jiribam, Thoubal.

(6) TRIPURA

Capital	Agartala	Females per 1000 males	963
Area (sq. m.)	4036	Literacy per 1000	202
Population	1,142,005		
Density (per sq. m.)	283		

(7) GOA, DAMAN & DIU

Capital	Panjim	Population	6,26,667
Area (sq. m.)	1431	Females per 1000 males	894
Goa	1394	Density (per sq. m.)	440
Daman	22		
Diu	15		

Important industries are paints and varnishes, straw-board, ply-wood, canning, rice and flour mills, bakeries, chemicals, mechanical toys, cement, *etc.*

(8) LACCADIVE MINICOY & AMINDIVI ISLANDS

Headquarters	Kavaratty	Females per 1000 males	1020
Area (sq. m.)	11	Literacy per 1000	233
Population	24,108		
Density	2192		

(9) ANDAMAN & NICOBAR ISLANDS

Capital	Port Blair	Density per (sq. m.)	20
Area (sq. m.)	3215	Females per 1000 males	617
Population	63,548	Literacy per 1000	336

Important crops are rice, rubber, coconuts, pepper, coffee, timber and cashew nuts.

(10) DADRA AND NAGAR HAVELI

Headquarters	Silvassa	Density per (sq. m.)	307
Area (sq. m.)	189	Females per 1000 males	894
Population	57,693	Literacy per 1000	95

(11) NORTH EAST FRONTIER AGENCY

Headquarters	Shillong	Density per (sq. m.)	11
Area (sq. m.)	31,438	Literacy per 1000	72
Population	336,558		

PROTECTORATES

(1) SIKKIM

Capital	Gangtok	Females per 1000 males	904
Area (sq. m.)	2,744	Literacy per 1000	123
Population	162,189	Languages	Sikkimese and Gorkhali
Density (per sq. m.)	59		

(2) BHUTAN

Capital	Punakha	Density (per sq. m.)	34.7
Area (sq. m.)	19,305	Language	Bhutanese
Population	670,000		

QUESTIONS

1 Divide Uttar Pradesh into natural regions and describe the characteristics of each region. Illustrate your answer with the help of sketch-maps.

2 Describe the urban population of Uttar Pradesh and account for its growth. (Agra, 1958.)

3 Write a regional geographical account of Uttar Pradesh. (A.U. 1967.)

4 Analyse the geographical factors responsible for the localization of any two of the following [illegible] Pradesh and give their future prospects:

(a) Glass (b) paper (c) Sugar.

5 Write a brief geographical account of Rajasthan or U.P. (A.U. 1960.)

6 With reference to Rajasthan, bring out clearly the relation between relief and climate and the distribution of population.

7 Write an essay on cottage industries of Rajasthan, suggesting lines of development.

8 Write a short geographical account of either Kerala or Himachal Pradesh. (A.U. 1961.)

9 Write a geographical account of either Haryana or Mysore.

10 Write a geographical account of Bihar or Chhota Nagpur plateau.